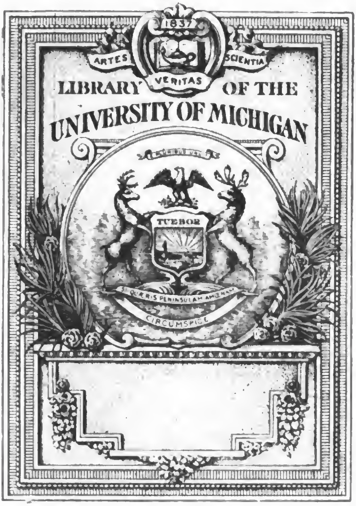
Memoirs of the Wernerian Natural History Society

Wernerian Natural History Society, Edinburgh



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MEMOIRS

OF THE

WERNERIAN

NATURAL HISTORY SOCIETY.

THE LIFE

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MEMOIRS

OF THE

WERNERIAN NATURAL HISTORY SOCIETY.

VOL. IV.

FOR THE YEARS 1821–22.

PART I.

WITH TEN ENGRAVINGS.

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ADVERTISEMENT.

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November 1811.

The Council of the Wernerian Natural History Society, *in order to meet the wishes of Authors of Communications, whose views and discoveries may be anticipated by delay in the publication of the Memoirs, have resolved that, in future, the Parts shall be published half-yearly, and that they shall be limited to the size and price of the present volume.*

May 1822.

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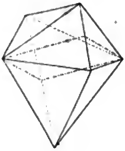

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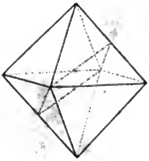

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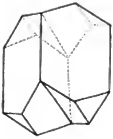

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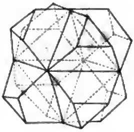

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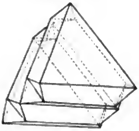

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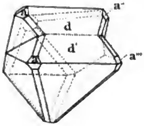

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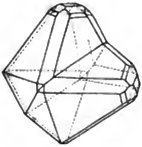

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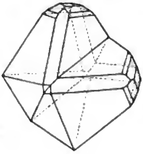

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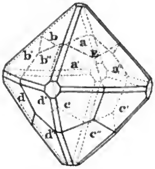

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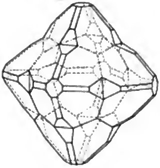

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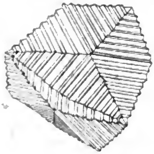

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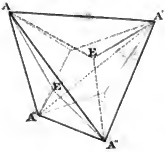

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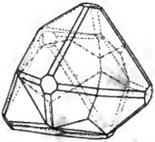

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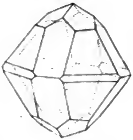

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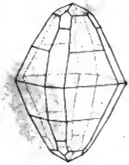

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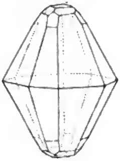

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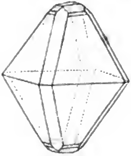

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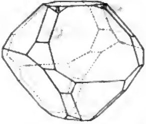

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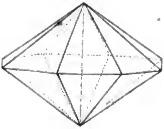

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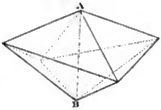

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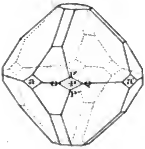

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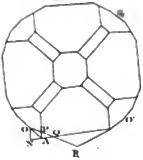

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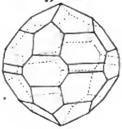

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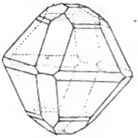

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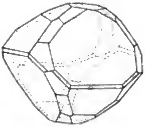

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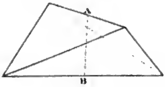

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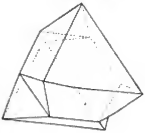
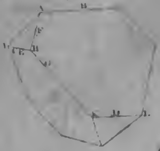


W. H. Lizars Sculp!

PLATE I.

Fig. 1



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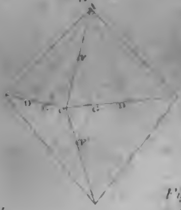

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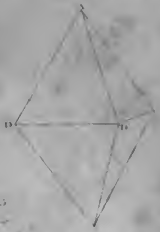

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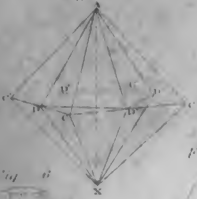

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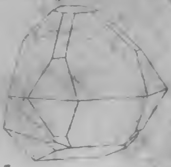

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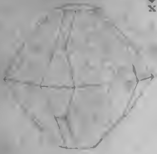

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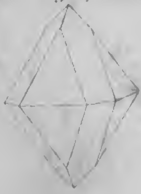

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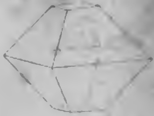

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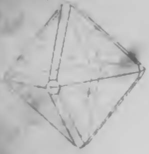

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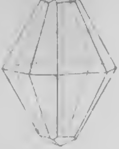

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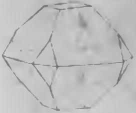

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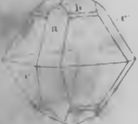

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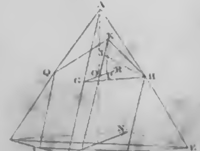

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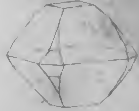

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MEMOIRS, &c.

I.—*On the Crystallisations of Copper-Pyrites.*

By W. Haidinger, Esq. of Freyberg, Member of the Wernerian Society, &c.

THE regular forms of Pyramidal Copper-Pyrites, a mineral so well known as an ore of copper, and so generally spread over the earth, have, till of late, been described very imperfectly by mineralogical authors. The crystals of this mineral were taken for octahedrons and tetrahedrons, modified by the cube, the rhomboidal dodecahedron, &c.; and the cleavage exhibited in the massive varieties was supposed to take place in the direction of the faces of the octahedron.

A group of very distinct crystals, which I had the opportunity of examining in the year 1817, shewed, however, forms entirely incompatible with that of the regular octahedron, and with such as can be derived from it. These crystals had almost the shape of tetrahedrons, with truncated angles, as in fig. 1. (Pl. I.) The solid angle H was replaced by a face of cleavage, the intersections EF and FG of which, with the adjacent faces, were parallel to the lines AC and BD in these faces, the said lines being perpendicular to the edges IH and KL. If by planes parallel to the smaller or triangular faces, A, I, H, &c. parts of this form are detached, until the remainder is contained under faces equal and similar to each other, the form will assume the appearance of an isosceles four-sided pyramid, as represented Fig. 2. The faces of cleavage are situated like those in the figure marked FEG, F′EG. In the hypothesis of the regular octahedron, four, or at least two, such faces should appear at each of the six solid angles; the result of which, in the first case, would be a *hexahedral trigonal-icositetrahedron*, in the second its *half*, the *pentagonal-dodecahedron*. This is, however, not confirmed by an accurate examination, since we find only four directions in which cleavage takes place, and this produces an *isosceles four-sided pyramid*, Fig. 3, the terminal edges AD, AD′ of which are parallel to the lines AD, AD′ in the figure 2, drawn perpendicularly from the apex A to the lateral edges of the given form. Supposing the axes of the two forms, of that of crystallisation, and that of cleavage equal, the horizontal projection or basis of the first CC′C″C‴ (Fig. 4.) will be a square *circumscribed* to the horizontal projection DD′D″D‴ of the second, and the sides of the bases CC′ : DD′ will be in the ratio of $\sqrt{2} : 1$. If, on the contrary, the bases are supposed equal, the axes of the same two forms will be in the ratio of $\frac{1}{\sqrt{2}} : 1$. Let the more obtuse pyramid be designated by P, the more acute one will be represented by P+1.*

These forms belong to the *Pyramidal System* of Mohs, and the crystallisation of Copper-pyrites can therefore, by no methodical means of proceeding, be derived from the regular octahedron, or any other form of the Tessular System.

---

* For the derivation of these pyramids, their belonging to a series of pyramids, and for the designation of its members, compare the *Supplement* to *Encyclopædia Britannica*, article Mineralogy.

By considerations of this kind, it became very probable that the angles of the four-sided pyramid of copper-pyrites would, by an accurate investigation, prove different from those of the regular octahedron. Such a difference has indeed been found by an immediate measurement with Dr WOLLASTON's reflecting goniometer, which yielded the angle at the basis of the four-sided pyramid = 108° 40′; due attention being given to all the necessary corrections required in the use of that instrument. The difference between this angle of 108° 40′, and that of the regular octahedron = 109° 28′ 16″, amounts only to 0° 48′, a quantity very easily missed in employing the common goniometer [*], for the determination of the angles. Moreover the crystals are commonly very small, which adds to the difficulty of having correct results from the application of this instrument. The little difference existing between the angles of the pyramid of copper-pyrites and those of the regular octahedron, the smallness, and after all the scarcity of distinct crystals, so as to have all their homologous faces of equal extent, sufficiently account for the incorrect ideas hitherto current among mineralogists respecting the system of crystallisation of the present species.

---

[*] The Abbé HAUY allows errors to be possible in measurements of this kind to the amount of a whole degree. He says, (*Traité*, t. ii. p. 325). "On voit que les différences entre les angles donnés par les deux hypothèses ne vont pas audelà d'un degré (being 0° 0′, 1° 1′, 0° 9′, 1° 0′), et que celle qui appartient à la troisième, n'est que de 9′. Or, quoique ces différences résultent de mesures prises avec beaucoup de soin sur des cristaux d'une forme très-nette, il est possible, après tout, qu'une erreur due à l'observation en produise de semblables."

The immediate measurement was nevertheless not required for proving these forms to be pyramidal. This is evident by their mere inspection, observing only how their edges of combination are situated; and it might have been found that the angles of the pyramid differed from 109° 28′ 16″ even less than could be determined by any measurement; without making the form by this only to cease to be what it was, an isosceles four-sided pyramid, and to change it into the regular octahedron. Naturalists thought themselves, however, still more confirmed in the last opinion by a sort of twin-crystals, very common in copper-pyrites, which bear a strong resemblance to those of octahedral and dodecahedral corundum, and of octahedral iron-ore, and, therefore, had been supposed to take their rise from the same forms, as in these species.

It will not be without interest to compare the chief mineralogical authors on the present subject, before we turn to the observation of Nature.

The first author that treats more at large of copper-pyrites, is **Henckel**, who wrote at a period when the future importance of crystallographical knowledge for mineralogy scarce was thought of. He gives in the Pyritologia (Leipzig, 1725, p. 157.) the description of those tetrahedral varieties whose forms have since been taken for the regular tetrahedron. The twelfth plate, however, "*Pyrites decaëdros,*" excepting only Fig. 2., represents a variety of copper-pyrites not uncommon in nature, and which we shall return to afterwards. From these drawings, founded upon correct observations, it might have been argued, that some one pyrites or other had a pyramidal form, though it could not be determined to which of them these observations referred.

Romé de l'Isle, and, after him, **Hauy**, consider the crystalline forms of this mineral as deriveable from the regular octahedron, or, more properly, from the tetrahedron. The latter even alleges cleavage to take place parallel to the faces of the tetrahedron, and gives the *Caractère geometrique* of *Cuivre pyriteux* thus:

> " Forme primitive. Le tétraèdre régulier, (fig. 78. pl. lxx.) Quelques cristaux offrent des indices de lames parallèles aux faces de ce solide."—*Traité*, t. iii. p. 530.

The forms he describes as modifications of the regular tetrahedron, and others in connection with it, moreover under the denomination of *Cuivre pyriteux transposé*, the twin-crystal mentioned above, which he compares with those of spinel.

Romé de l'Isle, in order to give a distinctive character between the hexahedral iron and the pyramidal copper-pyrites, states the crystals of the latter always to possess the form of tetrahedrons, more or less modified. *Crystallographie*, t. iii. p. 310.

But, says Hauy, sometimes copper-pyrites is observed in the form of the octahedron, perfectly regular; and since this form is equally found in iron-pyrites, the line of demarcation disappears. *Traité*, t. iii. p. 534.

The mineralogical works, according to the Wernerian method, infer uniformly copper-pyrites to have tessular forms, describing them as tetrahedrons, octahedrons, &c.

From a comparison of all the preceding, and of many other mineralogical books, it appears that none but Henckel's could excite even a suspicion that the form of the present species is pyramidal; and thus our endeavours towards the advancement of truth, in this particular, as well as in Natural History in general, will be the less subject to errors, the more strictly we follow the advice of that intelligent natural philosopher, in deriving our knowledge of the natural productions from the observations of those objects themselves.

The regular form most commonly exhibited by the crystals of copper-pyrites, is that represented in Fig. 5. The re-entering angles shew that it belongs to a compound, and not to a simple mineral. It is the same twin-crystal, which, from its great resemblance, has been confounded with those of the octahedron in Spinel and other minerals. The forms of the individuals can be obtained from the variety Fig. 5., by laying a plane through the re-entering angles, and turning one of the parts thus detached in this plane under an angle of 180°. The result of the operation is the form Fig. 6.

This form is not contained under planes altogether equal and similar to each other, and therefore is not a simple one. It is a combination of four different simple forms, to one of which belong the octagonal, to another the oblong rectangular, to a third the irregular hexagonal, and to a fourth the trapezoidal faces. Each of these forms is produced in succession, by enlarging the homologous faces, till the rest disappear. Thus the irregular hexagonal faces yield that four-sided pyramid, which by measurement is found to have the angle at its basis = 108° 40′, and for the present species bears the designation P. The trapezoidal faces are parallel to the faces of cleavage; their intersections with the faces of P are parallel to each other, and to the terminal edges of that pyramid, which results from the enlargement of the trapezoidal faces themselves; the axis of the pyramid therefore, as we have seen above, is equal to the axis of P multiplied by $\sqrt{2}$; and the pyramid itself, P+1. The rectangular faces likewise produce a four-sided pyramid, which, since it appears with parallel edges of combination in the place of the terminal edges of P, is to this pyramid in the same ratio, in which P is to P+1. Its axis will therefore be equal to the axis of P divided by $\sqrt{2}$, and itself the member P—1 of the same series, to which belong P and P+1. Lastly, the octagonal faces are evidently perpendicular to the axis of the combination, or to the common axis of the three pyramids, and give therefore a four-sided pyramid of an infinitely short axis, the limit of the series of isosceles four-sided pyramids, P — ∞.

The combination contains the faces of

$$P-\infty \,.\, P-1 \,.\, P \,.\, P+1.$$

The angle at the basis of P, and the relations of all the other pyramids to it being known, it will not be difficult to find the dimensions of all these forms. By immediate measurement the angle at the basis of P has been found = 108° 40′. From this follows by the formula,

$$a = \frac{1 - \cos. z}{1 + \cos. z}$$

the axis $2a$ of P $= \sqrt{7.7648}$. The axes of the members of the series being in the ratio of $1 : \sqrt{2} : 2$, &c., that of P—1 will be $= \sqrt{3.8824}$, that of P+1 $= \sqrt{15.5296}$.

If $2a$ signifies the axis of any isosceles four-sided pyramid, x the angle at one of its terminal, z the angle at one of its lateral edges, we have the formulæ,

$$\cos x = -\frac{1}{1+a^2}, \text{ and } \cos z = \frac{1-a^2}{1+a^2}.$$

The following table contains the angles of the three pyramids, calculated according to these formulæ, $2a$ of P being supposed equal to $\sqrt{7.7648}$.

PYRAMIDS.	x	z
P—1	120° 30′	89° 9′
P *	109° 53′	108° 40′
P+1	101° 49′	126° 11′

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* As it is given in M. Mohs' characteristic.

Some of the most remarkable varieties of forms hitherto observed in copper-pyrites are the following:

1. P. fig. 2. The pyramid of 109° 53′, 108° 40′, without any additional face. Commonly the alternating faces of this form are larger than the rest, a peculiarity of certain series of crystallisation, which, for the present system, has been called *Hemipyramidal* in Mr Mohs' characteristic. The form thus produced is that of fig. 1.; and it even sometimes happens, that the smaller faces disappear entirely, so as to give something like a tetrahedron, which, however, in reality is only *half* of an isosceles four-sided pyramid. Forms of this kind are very frequent in copper-pyrites, though in some cases they appear more striking than in others.

2. P. P+1. fig. 7. Sometimes the faces of the latter of these pyramids are much more extended than those of P. Very distinct specimens of this variety have been found in the mine Alte Elisabeth, near Freiberg, in Saxony.

3. P—8. P. fig. 8. The same variety to which Henckel's drawings of "*Pyrites decaëdros*" refer.

4. P—1. P. P+1. fig. 9.

5. P—2. P+1. $\frac{3}{2\sqrt{2}}$P+1. fig. 10. The first of these pyramids is in the same ratio to P—1, in which P—1 is to P. Its axis will therefore be

$$2a = \sqrt{1.9412};$$

terminal edge = 132° 19′;
lateral edge = 69° 44′.

The second is identical with the more acute of the second variety. The last is not a member of the principal series; in the seventh variety, its relations to the members of that series will be developed. The axis of this pyramid is

$$2a = \sqrt{17.4708};$$

terminal edge $= 100° 44'$;
lateral edge $= 128° 51'$.

Locality: the mines of Nassau-Siegen.

6. $P-\infty$. P. $P+1$. fig. 11.

7. $P-2$. P. $\frac{3}{2\sqrt{2}}P$. $\frac{3}{2\sqrt{2}}P+1$. fig. 12. The first, second, and fourth, of these pyramids, are already contained in some of the foregoing combinations. Their position to each other is the parallel one. We shall make use of fig. 13. for the developement of the relations in which the third and the fourth of these pyramids are to the members of the principal series.

The intersection of the face *b* (fig. 12.) of $P-2$, and the face *a* on one side, is parallel to that of the same face *b*, and the face *c'*, opposite to *c*, on the other. In fig. 13., both the faces *a* (LQKHF) and *b* (GKH) pass through the point H, and their intersections with *c'* (NAE) coincide therefore in the line HK.

OI is half the axis of the more obtuse pyramid, one of whose faces is *b*, if AO is half the axis of the more acute pyramid one of whose faces is *c'*; because, in this case, GH is the side of their common horizontal projection.

Now $GO : OI = GP : PK$, and from the similarity of the triangles KPO and AOR,

$$OA : PK = OR : OP.$$

From the triangles OKP and RKP being equal and similar, it follows that $OP = PR$, and $OP = \frac{1}{2}\ OR$, therefore $PK = \frac{1}{2}\ OA$.

Thus, the first proportion becomes

$$GO : OI = \tfrac{3}{2}\ GO : \tfrac{1}{2}\ OA,$$

and, $OA : OI = 3 : 1.$

The horizontal projections being equal, the axis of the more acute pyramid is three times as long as the axis of the more obtuse; from which follow the angles as they have been stated in variety 5.

The pyramid which appears with parallel edges of combination on the terminal edges of $\frac{3}{2\sqrt{2}}P+1$, is evidently $\frac{3}{2\sqrt{2}}P$, being the subsequent more obtuse member of the same subordinate series to which the other pyramid belongs.

Its axis is $= \sqrt{8.7354}$;
terminal edge $= 108°\ 18'$;
lateral edge $= 111°\ 50'$.

8. $P-\infty$. $P-1$. P. $P+1$. fig. 6. The same variety, which in the preceding we have made use of for the development of the three pyramids of the principal series. It is one of the most common varieties of copper-pyrites, and occurs more or less distinct in a great many localities.

9. $P-\infty$. P. $\frac{3}{2\sqrt{2}}P$. P+1. fig. 14. It would have been impossible to derive from this combination, without other forms entering into it, the relation of $\frac{3}{2\sqrt{2}}P$ to P; the pyramids of the subordinate occurring at the same time with P—2 of the principal series in variety 7. afforded the data required for this development.

10. P—2. $\frac{3}{2\sqrt{2}}P$. P+1. $\frac{3}{2\sqrt{2}}P+1$. $P+\infty$. fig. 15. (Pl. II.)

11. P—2. $\frac{3}{2\sqrt{2}}P$. P+1. $\frac{3}{2\sqrt{3}}P+1$. P+2. fig. 16. The most acute of these pyramids is the member subsequent to that which appears with parallel edges of combination in the place of its terminal edges. The last member, from several varieties already mentioned, is known to be P+1; and thus the new pyramid can be nothing else than P+2.

Its axis is $= \sqrt{31.0592}$;
terminal edge = 96° 33′;
lateral edge = 140° 31′.

12. $P-\infty$. P—2. $\frac{3}{2\sqrt{2}}P$. P+1. $\frac{3}{2\sqrt{2}}P+1$. fig. 17.

13. $P-\infty$. P—2. P. $\frac{3}{2\sqrt{2}}P$. $\frac{3}{2\sqrt{2}}P+1$. fig. 18.

14. $\frac{(P-n)^m}{2}$. P—1. P. P+1. fig. 19. This combination presents very distinctly the remarkable singu-

larity of the series of crystallisation of copper-pyrites, the alternating faces of P, and of other forms, to be much more extended than the rest of the faces of the same, which even sometimes entirely disappear. This last is indeed the case with the forms to which belong the small triangular faces *a*, *a′*, situated between the faces of $P-\infty$, $P-1$, and the enlarged of P. If all the faces of this form would appear, the result would be a scalene eight-sided pyramid, fig. 20; but instead of sixteen, we find only eight faces, and if we enlarge these, till they limit the space by themselves, the resultant form is contained under eight equal and similar scalene triangles, as represented fig. 21, which nevertheless is not a scalene four-sided pyramid, but must be considered as *half* of the eight-sided. This form is produced at once from the scalene eight-sided pyramid by enlarging the alternating *pairs* of the faces till the rest disappear. The dimensions could not be determined, on account of the want of parallel edges of combination between the half of the eight-sided pyramid, and other forms; besides the smallness of the crystals would not allow any application of a goniometer.

15. $P-\infty$. $P-1$. P. $P+1$. $(P+\infty)^3$. fig. 22. The present variety differs from that of fig. 6. only by its having eight rhombic faces disposed vertically round the axis.

Suppose fig. 23. to be the projection of fig. 22. upon a horizontal plane *.

If the faces *a*, *a′*, &c. are rhombs, OP' must be $= P'Q = QP'' = P''O$, and $OP = PQ$.

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* The letters signify the same in both the figures.

Now OP : PQ = NA : AQ, or, what follows from it, NA = AQ.

But since the angle OAQ is $= 135°$,

$$ON = NA,$$
$$\text{and } NQ : NO = 2 : 1,$$

which gives the angle OQN $= 26° \, 33' \, 54''$, and ORO′ $= 126° \, 52' \, 12''$, equal to the angle of the transverse section of $(P+n)^3$.[*]

16. $P-2. \ \frac{3}{2\sqrt{2}}P. \ \frac{3}{2\sqrt{2}}P+1. \ P+\infty. \ [P+\infty].$ fig. 24. Crystals of this form are very easily taken for tessular, particularly if they are fixed to some support, so as to allow only a few of their faces to be observed.

17. $P-\infty. \ P-2. \ P. \ \frac{3}{2\sqrt{2}}P. \ \frac{3}{2\sqrt{2}}P+1. \ P+\infty.$ fig. 25.

18. $-\frac{P-2}{2}. \ \frac{(P-n)^m}{2}. \ P-1. \ P. \ P+1. \ P+\infty. \ (P+\infty)^3.$ fig. 26. There occur in the present combination only the alternating faces of the pyramid P−2. By their enlargement we arrive at a solid contained under four isosceles triangles, fig. 27., analogous to the tetrahedron, and to that in var. 1., which is produced by the increasing of the alternating faces of P. The form is in the designation marked with —, to denote its faces to be alternating with the enlarged faces of P.

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[*] Encyclopædia Britannica, article Mineralogy.

The last of these varieties is hemipyramidal, not only by the two forms $P-2$ and $(P-n)^m$ entering into it with half the number of their faces, but also by the difference in the extension of the alternating faces of P. There is, however, besides this difference in the extension, still another existing between those faces, which can be of use, if attended to, in examining crystals very much engaged and grouped with each other. The enlarged faces of P always bear distinct *striæ*, parallel to the edges of combination of this form with $P+1$. Striæ in the same direction occur also upon the smaller faces of P, but they are generally very indistinct, and even, in some cases, not at all observable. The faces of the other forms are commonly smooth, and not streaked at all, only $P-1$ and $\frac{3}{2\sqrt{2}}P$ have sometimes a few horizontal striæ.

The variety in the forms of Copper-pyrites, and at the same time the difficulty of recognising them, is greatly increased by the scarcity of *Single Individuals* affecting the above mentioned forms. More commonly we find two or more individuals regularly grouped with each other; so that, besides compound forms, we have to consider compound minerals, in which, however, the composition takes place under certain crystallographic laws.

The regular aggregations or compositions of two individuals have received the names of *Twin*, or *Hemitrope* crystals, according to their being considered as produced by two simple crystals; or by a single one cut in two parts, in which the one half has undergone a revolution of 180° in the same cutting plane. In general, regular aggregations or compositions may be conceived to arise from several individuals, each two of which are in contact with each other in a face parallel to a face, or perpendicular to an edge of crystallisation, of any simple form belonging to the species; after having previously received such a position, that one of them is removed 180° from the parallel position with the other, in a plane, which is always parallel to a face of crystallisation of that species to which the individuals belong.

The *Face of Composition*, as well as the *Plane of Revolution*, may assume a great many different positions, only they must always be similarly situated in respect to both the individuals that are joined together.

The varieties of regular aggregation, or composition, hitherto observed in Copper-pyrites are the following:

I. The plane of revolution parallel to a face of P.
  1. The face of composition parallel to the same face of P. Form of crystallisation: P, fig. 28.
  2. The face of composition perpendicular to a terminal edge of P+1. Supposed form of crystallisation: P+1, fig. 29.

II. The plane of revolution parallel to a face of P—1.
  1. The face of composition perpendicular to a terminal edge of P. Supposed form of crystallisation: P, fig. 30. (Pl. III.)

III. The plane of revolution parallel to a face of [P+∞].
  1. The face of composition parallel to the same face. The result of this law in the form P, whose alternating faces are enlarged hemi-pyramidally, would be fig. 31. This, however, does not occur; the component individuals do not end in their face of contact, but parts of them appear also on the other side of this face,

and thus bodies are produced like that represented fig. 32.

The law expressed in I. 1. is the same that occurs in the variety, fig. 5, considered above; it is met with in many instances in those represented fig. 2, 7, 8, 9, 11, 14, 19, 22, 26. This sort of aggregation is very often repeated in faces parallel to themselves, from which, if it is in crystals, forms result like fig. 33. It extends, however, also to massive varieties, which then consist of alternating laminæ of this mineral to be distinguished from each other by the different direction of the faces of cleavage. It is evident that the alternating laminæ must be in parallel position with each other, on account of two revolutions of 180° being required in the same plane to determine the position of the third lamina in respect to the first.

The law I. 2. is not so generally found as the foregoing; it gives rise to forms as fig. 34, where the individuals are of the variety fig. 6. The faces a and a'; a'' and a''' of the pyramid P+1 fall into the same plane; so do the faces b, b' of the pyramid P. This is a necessary consequence of the face of composition being perpendicular to the terminal edge of the pyramid P+1; which edge is parallel to a line drawn on the face of P from the apex, perpendicularly to one of the lateral edges of this pyramid.

Some varieties, as that of fig. 12, are subject to the law II. 1., and then produce regular aggregations, as figg. 35, 36, in the latter of which, as is sometimes the case, the faces of $\frac{3}{2\sqrt{2}}$P, between the apices of the two individuals are wanting. The compound consists very often, by a repetition of this law, like that occurring in I. 1, of alternating laminæ, parallel, now to one, now to the other individual. The variety of regular aggregation, or composition, we have just described, and which takes place perpendicularly to one only of the terminal edges of P, is rare, and the very few instances I know of, are to be found among the varieties from Nassau-Siegen. But it is also met with, at the same time, upon all the terminal edges of P, and then it is one of the most common regular aggregations in the present species. The faces $a\ a'\ a''$, $b\ b'\ b''$, fig. 37, of the different crystals, fall into one and the same plane; which, of course, cannot be the case with the faces $c\ c'\ c''$, $d\ d'\ d''$, on account of the difference of the pyramid P from the regular octahedron. Crystals thus produced have been taken for simple, and described accordingly as octahedrons truncated on all their edges and angles. The appearance, indeed, is very seducing, if we do not attend to the striæ, which, in the different individuals, follow different directions, parallel to lines drawn from the point E to the respective apices of the pyramid P in the three individuals, whose faces meet in this point. The remaining parts of the faces of P+1 make sometimes re-entering angles, as in fig. 38, which adds to the evidence of such forms being compound.

The tetrahedral crystals from Cornwall are subject to the same law, only the individuals appear more decidedly hemi-pyramidal, so as to present only half the number of the faces of P. Generally they assume the form fig. 39, where the faces of $\frac{P}{2}$ are deeply streaked by the accession of the faces of P+1; though the mathematical regularity would require it to be so as represented fig. 40, where the lines AE, A′E; AC, A′C, &c. denote the junction of the different individuals. The striæ of the crystals are so deep and so numerous, that, instead of the faces AEA′, A′EA″, A″EA falling into one plane, the lines of junction AE, A′E, A″E are marked by re-entering angles.

The individuals do not invariably join in the aggregation according to only one of the laws expressed before; sometimes more than one exercise their influence at the same time. Thus the variety, fig. 41, is a compound of two parts, according to the law I. 1.; and each of those parts, again, according to the law II. 1., acting simultaneously on all the terminal edges of P. There are, in the same manner, crystals to be found, in which I. 2. and II. 1., others, in which II. 1. and III. 1., take place at the same time. In such cases, the resultant crystallisations commonly lose more or less of their regularity from the different relative size of the individuals entering into the composition; and it would, indeed, be sometimes difficult to point out the law it follows, had Nature not, since the streaking of the faces in every case is an effect of combination, and directed parallel to its edges, thus provided us with a means, which will always lead us the right way, and which, if duly attended to, is also of great moment for similar considerations in other species.

II.—*Notice of the Attempts to reach the Sea by Mackenzie's River, since the Expedition of Sir* ALEXANDER MACKENZIE.

(*Read 17th November* 1821.)

THE North-West Company first established a fur-post on the banks of Mackenzie's River in the year 1795, and have ever since maintained a greater or smaller number of establishments on various parts of its course. At present, the lowest or most northerly post is Fort Good-Hope, situate about 100 or 120 miles below the influx of Great Bear-Island Lake River, and, as is supposed, about three days' voyage in a light canoe from the sea, which, with the current of such a river, is usually estimated at from 50 to 80 miles *per* day. From the summit of a small hill behind the Fort, the upper limb of the sun is just visible at midnight, on the 21st of June.

In the immediate vicinity of Fort Good-Hope, and on the east side of the river, the Hare Indians reside; and their lands, to the northward of the very extensive piece of water which is named Great Bear-Island Lake, and which is said to be inferior in size to Lake Superior alone, borders upon the Eskimaux grounds, which skirt the sea-coast. The Fort is also visited by the Loucheux, or Squint-eyes, who inhabit the west bank of the river, and who are separated from the Eskimaux by the Vermilion River, about 2½ days' voyage below Fort Good-Hope. At this boundary, they often trade with the Eskimaux, and obtain, at a high price, certain smooth sea-shells, to be inserted as ornaments into the septum of the nose. They have also obtained at these friendly meetings, strips of whalebone, and pieces of the skin and other spoils of sea animals. Notwithstanding this occasional friendly intercourse, however, these two tribes more often enter each other's territories in a hostile manner; and so many of the Eskimaux have been cut off, that that nation is justly very jealous of the visits of strangers.

Two attempts have been made to reach the sea since the period of Sir ALEXANDER MACKENZIE's voyage. The first, by Mr LIVINGSTON, in the year 1799; when that gentleman, accompanied by JAMES SUTHERLAND, an interpreter, three Canadians, and three Indians, descended in a bark-canoe, a little below the Vermilion River above mentioned. Here they met with a single Eskimaux in his small seal-skin boat, whose first act, notwithstanding the disparity of force, was to discharge an arrow, which penetrated through the sides of the large canoe. They approached him, however; and adopting the mode in use among the Indian nations of discovering the intentions of strangers, presented him with a portion of meat, having first chewed a bit of it themselves. He threw it away with disdain, and refused to receive any of their presents; but directed them to put ashore, and made signs that his countrymen were at no great distance. They complied with his request, whilst he proceeded down the stream; and in a short time returned, accompanied with five of his companions, each in his small canoe, and armed with a bow and arrows. Mr LIVINGSTON endeavoured to conciliate them by presents of beads, and other articles; but instead of appearing pleased and grateful, they tied the strings to a pole, and cut them in pieces with their arrows. The Indians now warned Mr LIVINGSTON, that he would in vain attempt to establish a friendly communication with such people in their present state of mind, and were urgent for immediate embarkation, when it was discovered that the paddles of the canoe had been conveyed away by stealth. Such an unequivocal demonstration of a hostile purpose, increased the apprehensions of the party, and they hurried into the canoe, but were instantly assailed by a flight of arrows from the Eskimaux, each of whom shot three from his bow at a time. Mr LIVINGSTON and a Canadian voyageur fell under the first discharge: two of the Indians, who had not yet embarked, but were holding on the bow of the canoe, let go, and escaped into the woods, whilst JAMES SUTHERLAND and the other survivors floated down the stream. They were instantly pursued by the Eskimaux in their boats, and the Indians from their hiding places observed the conflict to be carried on until five of the Eskimaux were killed, and JAMES SUTHERLAND was left alone in the bow of his canoe, which was in a sinking condition. This much was learnt from one of the Indians, who travelled to Fort Chepewyan with the account of the melancholy catastrophe, having, in his route, had his wants supplied by parties of the Loucheux, and other nations he fell in with. It was afterwards ascertained, through the medium of the Hare Indians, that the canoe had drifted down opposite the main encampment of the Eskimaux, and that JAMES SUTHERLAND there threw himself into the water, swam ashore, and placed himself betwixt the knees of an elderly man, for protection. A consultation being now held, his destruction was decided upon: and as he was judged invulnerable from his having escaped from the conflict without a wound, they effected their purpose by tying a stone round his neck, and throwing him into the river; his protector having in the mean time conveyed himself away, it being contrary to their ideas of humanity that he should witness the death of his protegé.

The year following this tragical event, a party of the Red-knife or Copper Indians, making war upon the Eskimaux, at the mouth of the Copper-mine River, found some part of the clothing of Mr LIVINGSTON's party in the huts of those they destroyed.

A second attempt to reach the sea was made by Mr CLARKE in 1809. He descended the river as far as the assemblage of islands which form the various channels of which Sir ALEXANDER MACKENZIE speaks; but here a numerous party of Eskimaux, occupying both banks of the river, put themselves in such a menacing attitude, that it was deemed prudent to return, without making any attempt either to land or to proceed farther.

In 1810, a large shoal of porpoises came up to Fort Good-Hope, to the great grief of the natives, who declared that such visits were always attended by a falling off in the fishery, which accordingly proved very bad that season. This fact, we think, tends to prove the near vicinity of the sea, and that Sir ALEXANDER MACKENZIE either actually saw it, or was within a very short distance of it.

The country through which Mackenzie's River flows, appears to offer a fine field for a naturalist, and we have had many interesting accounts of it from those who have resided there. It is well worthy the attention of a mineralogist, who would have an opportunity of viewing the operations of Nature on a grand scale. The rocky mountains range along the western side of the river, at a greater or smaller distance from its banks; in some places receding to the distance of 70 miles, at others approaching the very verge of the stream, and at one spot below the Great Bear Lake River, a continuance of the same ridge appears on the eastern side of the river.

A kind of sheep frequents those mountains, which, from description, appears to resemble, or to be the same with, the *Argali*, or *Ovis montana*. It has very large, striated, spiral horns, and is clothed in the winter with a thick coarse coat of hair, like that of the rein-deer, which falls off in the summer, and is succeeded by a shorter and finer covering [*]. There is another animal of still greater interest, which the traders call the Goat, and which would appear to be a species of antelope. Its horns, smooth, short, and black, are directed backwards, with a slight curvature. It is about the size of a sheep, and, in the winter, has a coat of long curled hair, said to be of a silky fineness and lustre. It springs with great agility from precipice to precipice, and possessing, like the sheep, a very quick eye, its capture is attended with much difficulty. I have heard that the skins of these animals have been sent to Europe; but neither of them have hitherto been taken alive [†]. A very large kind of rein-deer is also found on those mountains.

The natives make knives of a white translucent stone, which they detach in large sharp-edged flakes, by greasing a portion of the rock, and kindling a fire upon it.

They also dig up an edible unctuous earth, similar, probably, to that which is found at the mouth of the Orinooko; and use as a pigment a mineral substance, which they find at the bottom of a small subterraneous stream. It is in the form of round, flattish, ponderous grains, of a shining black colour, with a greasy feel, and adheres to the skin only when mixed with grease. A large specimen of native silver was also found in that neighbourhood in 1796.

Near the Great Bear Lake River, there are some coal-mines on fire. And there are several fountains of mineral-pitch, one in particular, which rises in the channel of the river, at a spot, which, from that circumstance, is named the Flaming Point.

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[*] Specimens of the head of this animal were sent from Hudson's Bay by William Auld, Esq. to Professor Jameson, and proved to be the true Argali.—Edit.

[†] The animal described in the text appears to be the Rocky-mountain Sheep of the Americans, noticed by Professor Jameson in the third volume of the Wernerian Memoirs, p. 306.—Edit.

III.—*Geological Notices, and Miscellaneous Remarks, relative to the District between the Jumna and Nerbuddah;*

WITH AN APPENDIX,

Containing an Account of the Rocks found in the Baitool Valley in Berar, and on the Hills of the Gundwana Range; together with Remarks made on a March from Hussingabad to Sangar, and from thence to the Ganges.

By Dr Adam of Calcutta, Member of the Wernerian Society.

(*Read 12th January* 1822, &c.)

The specimens of minerals sent to Professor **Jameson**, comprise all the rocks met with between the Jumna and the Nerbuddah, by the route of Banda, Lohargong, Bellary, and Jubbulpore.

The first commences with the hills in Bundlecund, after crossing the Jumna. Between these hills and the river is situate a plain of considerable extent, the soil of which differs so greatly from that of the opposite country in the Doab, as to merit particular notice. It may be observed, generally, that the soil of the plains of Hindostan, from

Cannpore to Calcutta, and indeed from Hurdwar *intra Gangem*, is a light-coloured mould, consisting of a due proportion of argillaceous, siliceous, and calcareous earths, the last being most abundant above Marghyr. Its chief characteristic is derived from the quantity of mica which it contains, in minute grains and scales. This also prevails in the district which I passed through, from Allahabad to Chillyterrah Ghaut, on the Jumna. About half a mile to the north of this river, we descend a bank, which appears to form its boundary in the rainy season, and enter upon a low flat, where, in place of a fair, shining, attenuated mould, the eye meets nothing but an uniformly dull, coarse, black earth, not unlike the half-digested soils of muirlands at home. This dark soil is still more striking on the Bundlecund side, and continues almost the whole way to Besseramgunge. It seems to contain a larger proportion of argillaceous earth, and vegetable recrement, than the land on the left bank of the Jumna, and that which is generally observed in the upper provinces of India.

The Jumna, where the passage is made, is a smooth gently-flowing stream. The banks show no rock, but are high and perpendicular; and, when viewed from the opposite side, along with the advancing stream, the Cane, which here joins its waters to the Jumna, look uncommonly well, and are devoid of the dulness which characterises the whole course of the united rivers the Ganges and Jumna, below Allahabad.

On approaching the town of Banda, distant two marches, or about twenty miles from the river, several small hills are seen in the west, like erections for flagstaffs, posted at regular intervals. They appear to run in one line, from NW. to SE., and are of a conical, or rather pyramidal, figure. One of them rises from the plain close to Banda; it is about three or four hundred feet high, and is divided, at the upper part, into two or more smaller elevations, of which the central only terminates with a pointed summit. The appearance of the hill, from below, is singular and fantastic; huge masses of stone presenting themselves in every position, seemingly quite unconnected the one with the other, while a few shrubs, growing out from between them, serve as a contrast to the nakedness of the rock. On ascending the hill, we found it to be composed of a reddish-coloured small-grained granite, having no regular arrangement, but lying in blocks of great size, some perpendicular, and others horizontal, with a convex or rounded surface in general. Many of these are scaling off at the surface; but the greater part remain entire, and possess more compactness of integrant structure than any rocks of the kind which I have met with. This hill at Banda may be reckoned the termination of the first of the many series which traverse Bundlecund from W. to E., as no more are observed here following that line.

Soon after leaving Banda to the south, other hills come into view, which, at first sight, appear larger than the one at that place. This is chiefly owing to the effect of distance, increased by the dewy air of the morning, which is the time of travelling; for, on a near approach, we find these not to exceed the congeries at Banda, or the highest does so only in a small degree.

Though evidently entering upon a mountainous country here, we are surprised to find no general elevation of the surface, the same flatness of the plains continuing as on the northern side of the Jumna, and the hills rising abruptly from a common level, like so many islands rearing themselves out of the ocean. They are, in fact, mere pictures, on dry land, of the rocky Madeira, Porto Santo, or the Canaries, seen in the voyage from England to India.

About twelve miles from Banda, at the village of Geraiah, or Gerawah, we came to this second series. The general figure of these hills, like the former mentioned, is pyramidal; and they may be said, in this respect, to resemble a fragment of the granite rock which composes them. They stretch from the village of Geraiah in two or three directions, the line of some crossing that of others, and, notwithstanding their irregularity as a range, they appear to follow individually particular series; and we can trace a succession of isolated rocky elevations forming chains across the country. The largest of these, which is situate to the right of the village, has at the summit a rock of a white colour, like chalk, which I regretted, from the distance it was placed at, I could not examine. The others are composed of granite, similar to the rock at Banda, and present the same arrangement, or more properly, deficiency of arrangement, seen at Banda. At the lower part of one of those hills, quartz veins, distinct from the general composition of the granite, intersect it to a considerable extent; and on the summit, the blocks have assumed the shape of basaltic columns, standing perpendicularly, with four sides, which, at some distance, makes them appear like an overlying stratum of a different formation.

The country in this neighbourhood displays a thousand charms, compared with the district near the Jumna. The roads are dry; and the rocky elevations in front, having a covering of beautiful shrubs entwined with numerous varieties of climbing plants, give quite a new feeling to the mind on viewing the prospect. New animals, too, inhabitants of these, present themselves. The peacock, arrayed in all his gorgeous hues, and shining with a native glossiness of plumage, is not unfrequently seen perched on a projecting block of granite; while herds of antelopes bound along the plain below; and the shrill cry of the Indian partridge heard on every hand, first cheers the traveller with the opening day. I was much delighted one morning here, with viewing the natural phenomenon of sun-rise. Contrary to my usual practice, I had started early with my baggage. It was quite dark, excepting what light the stars afforded, which, in India, is always considerable at this season (October), when not a cloud obscures the expanded vault of the heavens. After moving on for some time, on turning my eye toward the east, I could perceive the first appearance of day. It was not dawn, but a mere greyish pillar of light shooting from the horizon upwards, in the shape of a comet's tail, but without lustre; the effulgence, if it could be so called, resembling that of the Milky-way more than any other object in nature which I have seen. This dull pillar of light was well defined. It continued a long time apparently little increased in size, and without having acquired much brilliancy. At length its sides near the bottom gave way; and the light, now stronger, diffused itself laterally to a considerable extent. By and bye the stratum of clouds immediately over this expansion displayed the roseate hue of morn, and the whole heavens became (though yet faintly) illuminated. The rosy tints disappearing in their turn, were succeeded by a greater degree of pale light; and soon after, the near approach of the great luminary himself was announced by a pillar of red, or orange-red, light, which terminated in the orb now appearing large and fiery, through the medium of the horizontal morning air. This is the general course of sun-rise in India, as I have frequently witnessed since. The precursory phenomenon of the pillar of light, with the successive changes, being then new to me, appeared perhaps more interesting on that account.

At Pungrawah, the second stage from Banda, we find the rock of the same nature as those already described. In the march from this last place to the village of Kurtul, a range of hills is seen in front, and on the left hand, much higher than any previously passed in the route, and which, instead of having peaked summits, are crowned with a flat table-land. About eight miles from the road, on one of the most conspicuous of these, to the left, stands the celebrated Fort of Callinger. We still find at Kurtul peaked hills composed of granite, similar to those at Banda, Gerawiah, and Pungrawah; and besides this, masses of a bluish-coloured trap are met with, and boulders scaling off in concentric layers. This trap-rock appears to have been at one time extensive, and I could trace a superficial stratum over the granite for some way up the hill. What remains of it rests on that rock without any distinct arrangement. The whole seems much affected by the action of the elements; and it is probable that, from this cause, a very large formation has been removed, and reduced to soil. Many of the granite-blocks here are also fast going into decay, and the soil of the district adjoining appears to be entirely derived from this source. Its colour is sandy-red, that of the felspar; and in this red sand, as a basis, are contained a great many small quartz-crystals, which still remain entire and unaltered in their structure. And the chalcedonic pebbles, found at the bottom of the hill, appear to have been imbedded in some rock, which had likewise at a former period rested over the granite. They are of the same nature as the pebbles found in the bed of the river Kane, so much admired on account of their beautiful variegated appearance and lustre when cut.

After leaving Kurtul, the road strikes into a wood of low trees, flanked on both sides by hills with flat summits; and, for the first time, we observe pieces of sandstone scattered over the path, mixed with broken blocks of granite, and the more complete detritus forming the soil. On one hill, which is nearer than the others, we can distinctly see a horizontal position of the superior strata, and under the table-face, a sort of projection enlarging the diameter of the hill, which gradually increases to the bottom. The upper formation is evidently of the same nature as the detached pieces of sandstone found below; while the great body of the hill is composed of granite, (and perhaps trap), similar to that of the pyramidal hills formerly described. Some Fugueers, or religious devotees, take up their abode on this hill, at the junction of the sandstone with the granite formation; and the face of their caves, cut out of the solid rock, and *chinamed* (or whitened) over, together with the elevated platform, on which are placed the objects of their idolatrous worship, present, from the plain below, a very striking and conspicuous appearance.

On passing the Fugueers' Hill, we come in sight of the eastern extremity of the Fort of Adjyghur, like that of Callinger, crowning the summit of an isolated hill, and owing its principal strength to a table-face of sandstone rock. The sides of the elevation, or the declivities, are covered with jungle or bushy wood, composed of beautiful low trees, whose leaves exhibit every shade of green, and every variety of size and shape, from the pinnated and pointed leaflet of the tamarind to the broad expanded foliage of the teak,—which last appears to be very abundant in all those hills. Granite forms the great body of Adjyghur, and sandstone lies over it at the upper part, presenting a perpendicular face of rock to the height of between 30 and 50 feet all round, and constituting a natural barrier of defence, which of itself seems to render the place impregnable. The position of the sandstone is perfectly horizontal, and the rock is in general quite fresh.

The view from the ramparts of the Fort displays well the peculiarity which I before remarked, respecting the want of general elevation in the whole of this mountainous tract. Hills are seen in every direction covered with jungle, rising abruptly out of an intervening flat country, the dull and cheerless aspect of which carries to the mind the idea of an uninhabited waste, or the haunt of savage beasts only. It is precisely the expression which DANIEL has given in the delineation of a fort in the Mysore, where a sort of sombre stillness (if I may be allowed so to term it) reigns, that no language can pourtray.

Adjyghur and Callinger are not less interesting to the antiquary, or mythological inquirer, than to the geologist; and the lover of art will find abundant subject of admiration in the beautiful remains of ancient Hindu architecture, which still exist within the walls of both these forts.

The country, for a short distance beyond Adjyghur, is open, and the soil again resembles that of the districts on the other side of Banda. A few miles farther on, we come to the village or hamlet of Besseramgunge, at the bottom of the Ghaut of that name. This Ghaut, or pass, leads from the low country of Bundlecund to the elevated table-land, on a level with the hills last mentioned. The path is cut through, or carried over granite, trap, and sandstone. At first, the ascent, though pretty steep, is not difficult, as there are few large stones, and no rock rising from the surface. Soon, however, it becomes steeper, and more obstructed, granite, trap, and sandstone masses presenting themselves in succession; and in many of the last may be perceived quartz-nodules included, like those found in the sandstone of the Table-Mountain at the Cape. The arrangement of the sandstone is in general horizontal, but at some points it appears to rise from the surface in the form of ridges almost vertical. The trap-rock exhibits no well-defined arrangement, at the several points where it is found in the Ghaut; and I could not penetrate into the jungle here to examine the strata more extensively. It may, however, be inferred, that it is in every respect similar to that rock at Callinger, which I have since found lying chiefly in roundish masses, of various sizes, occupying the middle of the elevation, and composing the greater part of it. These are in general mouldering at the surface, and many of the smaller boulders can be reduced to powder without the assistance of the hammer. The larger masses are more compact, and possess great soundness of structure.

The Table-land here is elevated about 1200 feet, I should suppose, above the plain of Bundlecund. On reaching the top of the Ghaut, we cross one or two clear running streams, and some oozing rills and pools of stagnant water are met with, most of which indicate, by their blue, slimy, and iridescent surface, impregnation with the iron of the adjoining soil. This is indeed composed of ferruginous gravel and disintegrated sandstone; and if we may judge from the fine luxuriant grass growing over it, it must be one of great fertility.

The Tonng Punnah, celebrated for its diamond mines, is distant about eight miles from the Ghaut; and in my march thither, I passed several of the mines, which are here close to the road, and have even encroached upon it at different points. It being late, I determined to defer my examination of these till the following day, which I intended passing at Punnah. Early in the morning, my servants, who had been dispatched for the purpose, brought intelligence that they had observed the workmen going from the town to the westward, with their implements of labour on their shoulders. Following them, I soon reached the scene of operation, distant about three miles, and in a situation perfectly corresponding with that on the other side of the town. It was a thin jungle (or wood), with long delicate grass growing in great abundance from a red gravelly ferruginous soil.

The mines are mere narrow pits, four, five, or more feet deep, according to the distance of the adjacent rock from the surface, and dug out of a ferruginous gravelly soil, which is of a dark reddish-brown, or blackish colour. It feels moist, and consists of fine sand, with a large proportion of small dark-red, and whitish or yellowish-white pebbles, the former appearing to contain a large quantity of iron. Three men were engaged in the search for the precious mineral when I arrived at the ground, the chief of whom very readily replied to all my questions, and explained and exemplified the series of operations gone through. These are indeed very simple. The soil, as it is brought from the neighbouring pit, is thrown into a small square excavation in the ground, about two or three feet deep, the bottom and sides of which have been well beaten, to prevent the gravel from adhering to them. A quantity of water being added, a man steps into the place, having an instrument like a broad hoe, with a short handle, (the common implement of the natives for all purposes), and mixes the whole together, using his hands also for that purpose, and tossing away all the larger pebbles which occur. This movement being continued for some time, the water is then thrown out by means of a small wicker-basket, and carries with it the sand, leaving the gravel behind. After repeated applications and discharges of water, the gravel is removed into another small bason of a circular figure, where it receives the last washing. From this it is conveyed to a large floor, on the surface of the ground, made of hardened earth, and there left to dry; the finishing operation consisting merely of a minute examination of the dry gravel, by a person acquainted with the external character of the jewel in its rough state. Judging from the condition of the people employed, one would hardly expect that they could be able to detect a diamond: but they assured me they did so with the greatest ease; and it appears to be the lustre and transparency, even in this state, which directs them. The principal man picked out several pieces of transparent quartz from the gravel, which he said resembled the diamond. He had " found them of all colours and sizes; but the discovering them," he added, did " not depend on" his " skill or exertions, it was altogether the work of God,"—*salaaming* at the same time, and pointing to the heavens.

From the inquiries which I made, diamond mining appears by no means a profitable concern at Punnah. Any one may dig, subject to paying the common duty of the fourth part of the produce to the Rajah, who is here, as in every other part of India, paramount lord of the soil. All stones, however, beyond a certain carat are claimed exclusively by him: but it may be supposed, where the means of concealment are so much in the power of the workmen, that the prince's treasury very seldom benefits much by this source of revenue. In the farm or spot which I examined, only two diamonds had been found during the preceding year, and these fetched each 200 rupees. The number of workmen commonly engaged in the various operations of digging, carrying, washing, and searching, is from four to five, though I saw only three. Of those, the sirdar, or chief, has a salary of five rupees *per* month, and the others four; and when a diamond is found, some present is made them by their master, proportioned to its value. So that, after paying the duty and expence of working, it is obvious, his gains, in this instance, must have been very small, and not sufficient to induce him to persevere much longer in his mining operations. Indeed the business of digging appeared altogether at a stand when I passed the ground; and from the remains of pits in every direction, it must have been carried on much more extensively at a former period than at present.

Punnah is on many accounts an interesting place. Spacious tanks, that would do honour to the most liberal State, are seen surrounded by temples and palaces, neglected indeed, but displaying often the elegancies of architecture, and serving as monuments of former grandeur and magnificence. As a contrast to the picture, we have only to cast our eye to the town itself, and view the condition of the present inhabitants, which is wretched in the extreme.

To return to the geological facts. Red ferruginous gravel, the matrix of the diamonds, may be considered as terminating the regular formation of the hills in this part of Bundlecund. The order of arrangement, from below, upwards, being granite, trap, sandstone, and gravel.

Before proceeding to describe the situation of the other rocks, it may be worth while to look back on the ground travelled over, and take a comprehensive view of these four formations, as developed at the sites mentioned, whether singly or in combination, and also to consider the general qualities of the soil in the intermediate and adjoining districts.

The prevailing soil in Bundlecund, and indeed to the south of the Jumna, is the black coarse earth already alluded to, apparently consisting of a larger proportion of clay and carbonized vegetable remains, than is found in the land to the north of that stream. It retains moisture more perfectly than the common soil of Hindostan: hence arises its miriness in the rainy season, and its disposition to unite into hard masses, and form rifts and hollows during the dry and hot weather. Even in its driest state, however, it has not the slimy compactness of pure clay-soils; but when separated into small pieces from the mass, is found to be quite friable, and easily reduced to powder. I think it probable that this contains also a proportion of magnesian earth, though, never having subjected it to chemical analysis, I am not warranted in drawing this inference from any accurate data. It is reckoned exceedingly fertile, and in no part of the Company's territories are more luxuriant crops displayed than in the districts where it predominates. Indeed, the richness of the Bundlecund lands, composed principally of this sort, is quite proverbial in India; and from its quality of retaining moisture, the process of irrigating them is less frequently resorted to, and the labour of the husbandman thereby lessened. It would appear, however, that greater exertions are necessary in preparing the soil for the seed, and also in keeping it clear of weeds, than we see applied to the common lands of Hindostan. A long grass was springing up every where at the time I passed through the district, and formed the only obstacle to the plough, which was then going in all directions.

One would suppose that the above characters of the soil should affect the climate, and render the plain of Bundlecund moist and unhealthy. As far as my own observation extends, agues are very prevalent in the whole of the low country, and sometimes prove so severe in European habits, as to require a total change of air for their removal; but the native population do not seem to suffer from any endemical diseases in a greater degree than the inhabitants of other parts of India; and their appearance, upon the whole, as presented to myself in passing along, rather indicated general good health and comfort.

This black soil has evidently been formed from the decomposition of some of the many varieties of clay-rock, most probably from trap and amygdaloid, which at one time had rested over the granite in the hills of Bundlecund.

It is probable the rock at Gerawiah, and the trap formation observed on the hill of Callinger, and at Besseramgunge, have had their share in contributing to it. The vegetable matter with which the soil appears to be impregnated in a more than usual degree, may have been derived from extensive forests, which it is not difficult to conceive had flourished here at no very distant period; and the successive increase of a heavy, plastic, moist soil, covering the wood with each return of the rainy season, had also prevented its complete decay. For the amelioration or improvement of such a soil in Europe, the agriculturist would have recourse to lime, as rendering it drier, and reducing the vegetable matter which it contains, to a state more fitted for supplying the requisite pabulum to the growing plant. In India, however, such an expedient would not be attended with success, as calcareous earth, in this country, unites together into small masses, constituting what the natives term *Kunkur*, and does not mingle with the other ingredients of the soil, unless siliceous sand exist in an unusually large proportion. This isolation (if it may be so termed) of the calcareous earth, is very well seen in the Baitool Valley, in Berar, where the soil is essentially the same as the coarse black earth of Bundlecund. It is probable that a mixture of sand would be attended with a beneficial result; for wherever I have observed this combination from natural causes, the effect appears highly favourable. An illustration of this occurs in the route between Callinger and Allahaba, *via Turrawa*, where we approach the Jumna, and the alluvial sandy deposite of the river is seen mingling with the dark earth of the plain. From this union results a soil possessing every requisite quality, and perhaps the best suited for grain-crops of any in India. The district in which it abounds well merits the poet's appellation of "*lætus ager*," and is certainly not inferior to his boasted "*Gargara*," in the ease with which it is cultivated, and the ample products it yields the husbandman in return.

From the appearance of the soil between Callinger and Allahabad, as I observed it in passing along, I could not help drawing an inference, which, if correct, may throw some light on the situation of the ancient capital of the Prasii. The city of Palibothra, we are told, was situated near to the hills, and at the conflux of the Ganges with another large river; and it is the difficulty of reconciling these two circumstances with any modern locality, which has given rise to so much discussion and disagreement among the learned. Indeed, no spot that I am aware of, in Hindostan, includes them both; for Allahabad and Patna want the former, and the neighbourhood of Bhungulpore, which Colonel Franklin endeavours to identify with the ancient city, is defective in the latter. We are therefore compelled to believe, that some change must have taken place in regard to the one or the other; and, as alterations in the course of the river are of daily occurrence, while the removal of mountains can only be effected by a great physical convulsion, or the agency of supernatural power, it is most reasonable to infer, that the junction of the rivers had occurred nearer to the hills, at a former period, than at present.

What is thus assumed, from a general view of the question, made with reference to the Jumna and Guna, appears to me to be confirmed by facts; and I think it exceedingly probable, that the latter river has at a former period flowed close to the front range of hills in the north-east extremity of Bundlecund, and that it has gradually forsaken that course, as its earthy contents came to be deposited on the bank. At a short distance from the hills, we find the alluvion of the river mingling with the black earth; and long before we are out of sight of these, the soil seems almost entirely composed of a deposite from its waters. Granting, therefore, that the Jumna held its course farther to the south than the present bed of the river, we can easily conceive that the sister-stream of the Ganges may have joined its waters also more to the south and east than the present point of confluence at Allahabad, and in a situation so near to the hills, as to correspond in every respect with the account handed down to us of the site of Palibothra by ancient writers.

From the very cursory glance I could bestow on the district, in passing through it, I am not in possession of such exact information relative to the changes in the appearance of the soil as I could wish, and as would be necessary to form an accurate conclusion on this particular point. It appears to me, however, that were the existing geological relations of countries more attended to and studied, many disputed points in reference to their ancient history would be determined, and rules established, for the guidance of the antiquary, which would materially abridge his labour and research.

The other soils in Bundlecund are those formed from the debris of the granite and the sandstone rocks. The first is found at the village of Kurtul, and is very limited; the sandstone soil is seen between that village and Adjyghur—it is more extensive than the other; but as it abounds above the Ghaut, after passing Punnah, the account of its qualities will be best given along with the appearance of that district.

The appearance of the first hills, after entering the Jumna, has been already detailed. It is quite characteristic of the granitic formation. Their outline, contrasted with the table-summits of the ranges in the interior, exemplifies in a striking manner the effect of the rock in the figure of the general elevation, from which, at the distance of many miles, we can often determine the nature and position of the strata forming very extensive ranges. The bare aspect of these granite piles, in the first range, and the irregular surface which they present, lead one to conclude, that they are but the remains of hills of a much greater extent, which have once existed here. They may be said to exhibit the *cores* of large hills, whose exterior has suffered in the lapse of time, while the more compact structure of the granite still enables it to resist the common causes of decay. I think it can hardly be doubted that all hills, similar to those met with in Bundlecund, have been originally formed by a force from below, elevating the primitive rocks, and causing a disruption of the secondary strata, at the several points at which it had been exerted. Where the force was but slightly impressed, and in a limited area, a small elevation would be formed. The granite would then only break through the superincumbent strata, without carrying them along with it, while the broken strata would rest on the sides of the mass, after the impelling force ceased to act. The figure of the hill then would not be a pyramid, which it now resembles, but would approach more to that of a cone; sandstone, trap, &c. lying on and surrounding the granite, and filling up its inequalities, and the direction of the strata of each of these deviating more or less from the horizontal line, in proportion to the elevation of the central mass. We could thus picture a hill more extensive than any of those now existing in the first series, whose sides at the surface were originally composed of sandstone ledges, and the summit of a pointed block or mass of granite, or, crowning the whole, may have existed a table-land, of comparatively small dimensions. Their original height, in that case, may have been from 30 to 50 feet greater than their present, that being the average depth of the sandstone strata in the hills in the distance. Indeed both these ranges have been produced by the same causes, and have at the time been composed of similar materials; the sole difference arising from the size of the primitive or granitic base. The process of reduction or diminution of their bulk may be conceived to have taken place in the following manner. The sloping sandstone on the sides of the hill, being acted on by the elements of air and water, joined to the heat of the sun, had first suffered disintegration. The sand thus produced would be washed down by the torrents in the rainy season to the bottom of the hill, where it would spread out, and form soil. This operation continuing, the whole of the inclined sandstone would, in course of time, be removed, and the trap, or other rock, immediately beneath it, would thus be exposed in its turn. From the same causes which acted on the sandstone, this would also undergo a change, and ultimately be reduced to soil, which would spread over the detritus of the former. The small table on the summit, in the course of these operations, falling into fragments, and rolling down the hill, would also be exposed to the same successive changes; and thus, after the lapse of ages, nothing would remain but the central primitive granitic mass, as it is now displayed.

This view of the original structure of these eminences, and the changes which they have undergone, is supported by the present state of the larger hills in the distance. We see them covered by a table of sandstone still entire, resting on an extensive pyramid of granite, on the sides of which are found trap and pieces of sandstone, and, at the bottom, a soil composed of their detritus, being either a pure sand, or a dark-coloured rich earth, according to particular localities.

It is obvious how the table-summits of the larger hills yet remain of great extent. Though at first exposed to the same decomposing action as the sloping strata, this could only go on for a short time. The surface of the rock suffering decomposition, plants of various sorts would take root, and grow and bind together the new soil; and shrubs and trees by degrees shooting out, would add to the effect of the herbage by affording a shade, and in so far obviate the influence of the sun's rays, in contributing to the process of disintegration. A deep jungle being in process of time produced, no farther changes would occur in the subjacent rock, excepting in its perpendicular faces, where the alternations of seasons might occasion fragments to be detached and precipitated to the plain below, or the descending water, in the rainy months, might wear out channels in the surface, and carry the sand to the bottom of the hill.

The ferruginous conglomerated gravel and sand met with here is entirely a secondary production, and the process by which it is formed resembles, in some respects, that of the calcareous Kunkur, to be afterwards described. It appears to be decomposed sandstone, united again by means of iron, in a low state of oxidation: I am also disposed to believe, that the iron has been derived, not from a mineral, but from a vegetable source; that it is, in fact, the product of decomposed ligneous fibres, which chemical analysis shows to contain a portion of this metal. The successive decay and production of vegetable matter would in time accumulate; the iron and the acid-water, also formed by the decomposition of vegetables, in the rain, would in part dissolve it, and impregnate the sand over which it rested. Evaporation taking place, on the accession of the dry season, would complete the process by the abstraction of the menstrual fluid; while the metallic oxide would enter into a more intimate union with the earth. The chalybeate pools at the top of the Ghaut, and oozing rills before mentioned, may be supposed therefore to constitute the active instrument in the formation of the ferruginous gravel.

It is remarkable, that the gravel-conglomerate should form the matrix of the diamond in Asia and America, and, I believe, in every quarter of the globe where the gem is found, while almost all the other precious stones are included in solid rock, of which they constitute, as it were, an integrant part, or are found along with its debris. How far this peculiarity may be connected with the singular chemical nature of the diamond, I cannot pretend to say; but the fact appears of importance in reasoning on the origin of this highly prized jewel.

With Punnah, we leave for some time all traces of cultivation, and enter upon a beautiful jungle, which continues nearly ten miles to the village of Kukurettee. The soil is entirely formed from the debris of red sandstone, without gravel, or apparently any impregnation of iron. It is of a red colour, dry, and fertile, and seems peculiarly adapted for the culture of the vine. To the right and left of the road, sandstone ridges, several hundred feet high, rise from the general level of the table-land, and present the same horizontal arrangement as the sandstone described. There is a perceptible elevation of the surface in this course, and the path appears to cross the range of hills, there being a slight descent as we approach Kukurettee; where the country again becomes open and cultivated, and displays the same dark-coloured earth which was so often met with below the Ghaut.

On the march from Kukurettee to the cantonment at

Lohargong, I discovered a mass of rock apparently consisting of alternate layers of limestone and sandstone; and soon limestone strata were found projecting from the ground, having, in many places, a very thin covering of soil, and scarcely any vegetation over it. The bareness of the plain here is altogether remarkable, and cannot fail to strike the traveller, after passing over the jungle district to the north. The effect of the limestone on the soil appears unfavourable. It does not undergo decomposition; and, in place of being soft and corroded like the sandstone, the strata, I observed, were exceedingly compact, and the surface of all the exposed masses rounded off, with a sort of semi-vitrescent structure, as if the rock had undergone fusion. The aspect of the whole district about the cantonment is barren and desolate, nothing but a reed or rushy grass being seen, and very little of the ground in a state of cultivation. It is not easy to discover the arrangement of this rock, as there are no elevations or ravines to give an opportunity of examining it minutely. The limestone formation, as I have since ascertained, is of great extent; traces of it are found about 70 miles to the west, on the Sangar route; and it is probable that it stretches to the bottom of the hills to the eastward of Lohargong, occupying the greater part of the basin inclosed, and formed by the ranges on both sides here.

A few miles to the south and west of Lohargong, the ground becomes more moist and clayey, and this change is quickly explained by the appearance of a coarse schistose sandstone, which I found very abundant here. It seems, however, to contain also a large proportion of calcareous earth. On crossing the Cane, near the village of Kopah, the thin horizontal layers of this rock are very conspicuous on each side, and the bed of the river seems to pass through it. The Cane here is rather more than 100 feet broad; but it was quite fordable in the latter end of October, when I passed it.

The village of Kopah leads directly to another range of hills, which rise out of the general table-land, and form the southern side of the basin of Lohargong. They are less abrupt than those passed between Punnah and Kukurettee; but their aspect, though not so striking, is much more beautiful, displaying every variety of shade in the foliage which covers them, and affording a rich and romantic diversity of prospect that is nowhere exceeded. The sandstone which composes them, like the former, is in general horizontal. From Kopah to Bisseenie is 18 miles, from Bisseenie to Syennggur 10 or 12, and from this last to Bellaree as much more. The whole of the district is hilly, with numerous streams passing over it, and presents the same general features throughout. Specimens of a red-coloured decayed amygdaloid were taken from the hill above Bellaree, where it is very abundant, in the form of large masses, lying apparently over sandstone. On descending this hill, the country again opens before the view, and a large plain, with trees dispersed over it, is seen extending in every direction.

From Bellaree, to the next stage of Coreah, I travelled by night, and in consequence could not observe the appearance of the country. At one point, where the road passes over a small elevation, the rock projects from the surface in vertical ridges, in a singularly abrupt manner; and, as far as could be perceived by the feeble light of a waning moon, it partakes of the same general nature as the sandstone so often mentioned.

In the next march, quartz-rock was observed, and some beds of grey-coloured splintery foliated limestone adjoining to these, had a peculiar striped arrangement, and, in colour, lustre, and compactness, were not unlike the limestone of Lohargong. When I reached the town of Sehorra, I found these two rocks, and some others, forming a small hill, on which the Fort, or Ghur, is there placed. The other rocks are quartz, and a beautiful slaty variety of iron-glance, which bears so great a resemblance to primitive clay-slate, that we at first confounded it with that rock. They are disposed in thin and nearly vertical strata, and alternate and intermix with each other. In some specimens, the slate is singularly striped with various coloured materials, which appear to differ in their hardness.

The village of Sehorra, where these rocks are found, is prettily situated on two or three small gradually rising eminences, having a good deal of open glade, which is flanked and terminated by mango-groves, in such a manner as to give the whole the air of an English scene. The soil of the district around is of the same black colour as that of Bundlecund, but is more clayey. It is extremely fertile; and the appearance of the surface, at the time I passed here, indicated great care and attention on the part of the Ryots. For some distance to the south-west of Sehorra, not a spot could be seen which was not cultivated, and laid out in square pieces, with an intervening low mud-dike, similar to the paddy fields in Bengal.

A few miles beyond Sehorra, we pass the Ilim, a stream of considerable width, which falls into the Nerbuddah, a little to the westward. The bank is not rocky, like the Cane at Kopah, but formed entirely of sand, without any gravel or pebbles. Some large masses of a variety of round granular red iron-ore are met with at Gossulpore, a sweet little village, which we pass between Sehorra and Punnahghur. The soil is formed from the debris of this rock, and is dry and fertile.

In the march from Punnahghur to Jubbulpore, we cross the Periot, (or Pracu, as ARROWSMITH has it laid down in his Map of India), whose channel abounds with every variety of agate and siliceous pebble.

The calcareous concrete, formerly mentioned, which the natives term *Kunkur*, occurs between Sehorra and Punnahghur; but the finest specimens of the kind are got on the banks of the Ganges, from Ghazapore to Caunpore. This Kunkur, the calcareous tuffa of Werner, which is so abundant every where in the soil of India, deserves notice. On taking up a piece from the ground, its irregular figure, from the knoblike projections, or mulberry surface which it exhibits, leads to the inference, that it must at one time have been in a state of fusion or solution;—that fire or water has been the active instrument in its formation;—a stalactite, or rather a stalagmite, and a slag from the furnace of the founder, or a cinder from a blacksmith's forge, presenting a similar appearance. It appears to be a product of the latter agent chiefly, or the joint effect of moisture and dryness, on the calcareous and other earths, in the succession of hot or dry and rainy seasons which occur in this country.

The calcareous earth abounding in the soil, is, during the rains, alternately exposed to the full action of water, and the direct rays of a powerful sun; and the union which is thus effected, is rendered more perfect during the succeeding dry and hot months. It is not so easy to explain from what source the calcareous ingredient has been originally derived, as limestone-rock does not appear susceptible of decomposition from exposure, in the manner of most other rocks in India;—such, at least, as I have seen preserving its structure at the surface, and displaying an extraordinary degree of compactness. The extensive strata of kunkur found in the great plain of Hindostan have been evidently formed by the waters of the Ganges; and it is highly probable their materials have been furnished from the detritus of limestone-rock, in the passage of the mountain-torrents over them, at no great distance from the head of the river, or at least within the first range of hills.

Near the town of Jubbulpore, we pass a ridge of granite rocks or hills, which resemble those first met with in Bundlecund, but which do not rise to the same height, and are less conspicuous from the greater continuity which they observe. Many of the masses approach to the gneiss formation, and they seem in general to be suffering a rapid decomposition. The cantonments at Jubbulpore are situated to the east and south of the town, on an open plain, which bears only a coarse grass, and a few shrubs or frutescent plants, if we except a decaying mango-grove in the centre of the building. The district around is rocky, and offers a fine field for the geological inquirer; but my short stay would only admit of a very cursory glance over it. A formation of sandstone, directly south of the cantonment, which appears to have been extensively quarried, has the peculiarity of being arranged in strata perfectly vertical, contrary to what is usually observed in the rock. A large mass of a whitish clay-rock, containing quartz-pebbles, forms the base of the hills, to the east of the plain. It appears to be washed down by the rains into powder, and formed anew into a boulder, or a cake, at the surface. The ridge lying over this, north and east, displays the primitive outline; and hence, I conclude, consists of the same granite-blocks which are observed at the entrance to the town from the north.

At Jubbulpore, we enter upon the great valley of the Nerbuddah, extending from the Forty Mundelah to beyond Hindra, through a space of at least 250 miles. The river, where we cross it at Tetwarra Ghaut, is a clear mountain-stream, not much wider than the Cane at Kopah, but of greater depth, being seldom fordable here before the end of November. The bed is entirely rocky, and, in as far as I could judge in passing, the rock is a variety of trap, having a position nearly horizontal. A few miles lower down, I am informed, the river passes over a formation of marble, of the purest white colour, and with a granular structure. I met with some masses in the jungle soon after crossing the Nerbuddah, which appeared to be of the same nature. At the river, it is quarried by the natives, who make images and various religious ornaments of it. I saw a very large block in progress at the town of Huttah, in Bundlecund, when I left that part of the country, which the people told me had been brought from the Nerbuddah. It appeared equal to the finest marble I have seen in England, and might well come in competition with the admired Parian and Pentelic marbles of old, or the Carrara of modern times. The image which was then under the chissel represented the God *Sira*, or *Mah-ded*, (*Magnus Deus*), and his consort Bowannee; and though finished in the usual heavy style of the Hindoos, the execution was yet sufficiently delicate to display the excellence of the materials, which I admired greatly. The specimens of the rock, with many others, I regret to say, have been lost, through the carelessness of my servants, during my long march from the Nerbuddah; but I expect soon to be able to replace them, and transmit to you several others from that part of India, as a friend there has kindly undertaken to supply me.

The valley of the Nerbuddah is formed by two principal ranges of hills, which inclose it, and run nearly parallel to each other through its whole extent; the Vindhya, in the Malwa district, on the right,—and the Gondwana, in Berar, on the left. These are both composed chiefly of sandstone, the Gondwana displaying often perfect table-summits, with a horizontal arrangement; while the strata of the opposite range dip very considerably to the westward,—and this inclination is more conspicuous the farther we proceed in that direction, till we reach Hussingabad, when the angle with the horizon, in some instances, exceed 45°. Opposite to the Company's military cantonments at this place, the appearance of the sandstone strata cannot fail to strike the most indifferent observer. The hills rise from the west, like the waves of the ocean, gradually swelling, till they terminate abruptly to the east, with a perpendicular face, many hundred feet high. There is a small elevation to the south of the Nerbuddah, and in front of the Hussingabad cantonment, which displays the same arrangement, and has evidently been of cotemporaneous formation, though distant about five or six miles from the principal range. The rock is primitive sandstone, similar to that of the Bundlecund hills, and is in common use for building, for which it seems well calculated. Looking at those ridges of hills on the north of the Nerbuddah, and comparing their singular appearance with others of the same general structure, parallel to them, or even composing part of the same line, we cannot hesitate in pronouncing that they must have been elevated, or heaved up, from the horizontal position, by a subterranean force acting with *successive impulses*, and in all probability have owed their origin to a violent earthquake, which has happened at a period far beyond record or tradition, or perhaps even the existence of the human species. The earthquake which occurred on the 17th June last year, only wanted force to have raised a chain of hills of the same character, from one side of the base of the Indian Peninsula to the other, from the Gulf of Cumbay to the bottom of the Bay of Bengal. It was a succession of *long heaves*, very different from what are usually experienced and denominated the shocks of an earthquake; the undulatory motion being prolonged and repeated over the surface in such a manner, as to appear to have proceeded from a vast depth, and to have originated at a great distance from where it was felt by myself. This earthquake was general over India; but its sensible effects were most remarkable in the Guzerat district, where it seems to have been destructive, and to have created much alarm.

The Gondwana range of hills is considerably higher than the other, rising, near Sohagpore, to an elevation of 800 or 1000 feet (or probably much more, as I had no means of ascertaining this but from their appearance at a distance) beyond the level of the valley. I have been informed, by a friend, who entered these hills against the insurgents in the end of last campaign, that rich valleys lie between many of them, and an extensive table-land often covers their summits. The plain of Puchmerry, where the head-quarters of the Ex-Rajah Appah Sahib were fixed, during the rains of 1818, is an elevated table-land of this description, covered with the most beautiful verdure, and having many large trees scattered over its surface, reminding one of an English park more than a scene in the burning climate of Hindostan. Extensive beds of iron-ore were found here by the gentlemen who accompanied the troops; and from the appearance of the hills, I think it highly probable that they abound in various mineral productions. Iron is exceedingly scarce and dear in this part of India, and the reduction of the ore becomes therefore an object of importance. There is no want of wood to accomplish this, and I have every reason to believe that coal exists in the same hills, and near the situation of the ironstone. The specimens of coal sent, were found in the bed of the Towa river, which runs through these hills, and falls into the Nerbuddah, a few miles east of Hussingabad. I examined the banks of the Towa, where the specimens were got, but could not discover any appearance of strata, nor impregnation, in the adjoining soil, and, from the rolled and worn surface of the pieces, it was evident they had been brought down by the stream from a distance.

The soil of the Nerbuddah Valley, all the way from Jubbulpore to Hussingabad, consists of a black coarse earth, like that of Bundlecund, having its surface strewed over with chalcedony and agates. It is very fertile, and, in some places, well cultivated; but a large portion of the country is jungly, and in a state of nature, deep forests extending from the bottom of the Gondwana hills to the river, which, in its whole tract, skirts along the opposite range to Malwa.

The specimens which I have now the pleasure to send, were procured chiefly from the Baitool Valley, in Berar, and the hills of the Gondwana range leading to it.

APPENDIX.

SECTION I.

Containing some Account of the Rocks found in the Baitool Valley, in Berar, and on the Hills of the Gondwana Range.

ON crossing the Nerbuddah Valley, at Hussingabad, we enter on those hills, about 15 miles to the south, near a village named Petrora. The intermediate space is partly cultivated, and partly in a neglected state, being overrun with a tall coarse grass, and having an occasional clump of shrubs or low trees. Its aspect is bare, and indicative of a deficient population, which indeed may be said to characterize the whole of the district. The hills are considerably lower here than to the eastward, being in general of a conical or dome-like figure, and covered to the summits with trees of the same low description as those of the Bundlecund range. They are composed partly of trap-boulders, especially the first met with; but the principal rock, all the way to Baitool, is harder and more compact than sandstone, but less so than perfect quartz. Its position is quite vertical; and this stratification is best seen in some ridges situate near the village of Teekaree, immediately after descending the Ghaut, which leads to the valley. At Shawpore, I found a very extensive formation of secondary limestone. There are some cultivated grounds near that village; but with this exception, the whole road, for a distance of 50 miles, passes through one continued jungle, composed of a great variety of beautiful trees; among which, the *Cassia fistula* (the Awmiltass of the natives) is very conspicuous; and another tree, which yields vast quantities of the purest and most pellucid gum I have ever seen. At the time I passed through these hills, this last was destitute of leaves and quite bare, so that I could not determine its botanical characters. It attains a middling height; the branches shoot from the main trunk, much like the common plane-tree, and the bark is of an unusually dark colour. Vast quantities of gum, the produce of this tree, might be got in those hills, as it appears to be very abundant from the Baitool district as far west as Afsarghan.

After passing the quartz formation in Baitool, we come to granite, which is seen in large ledges or masses, and is principally remarkable for the great size of the felspar concretions. The granite disappears under rocks of secondary greenstone, which form the hills adjoining to the village or town of Baitool, and these rocks continue to form the bed of the Baitool Nullah, or rivulet, to near the town of Teckaru, where the granite again appears. The greenstone is sometimes amygdaloidal, and contains agates of various descriptions, and veins of calcareous spar and amygdaloidal green earth.

The soil of the valley appears to be directly formed from decomposed secondary trap-rock, and, at a little distance, it is difficult to distinguish the solid mass from the fresh friable earth. This soil resembles in every respect that of the Nerbuddah Valley, having a great variety of pebbles of chalcedony and agate scattered over the surface; and, besides these, there are met with, at different parts, rounded calcareous concretions, which are varieties of the kunkur formerly alluded to. On breaking these, we find them hollow, and the internal surface studded over with crystallisations of calcareous spar.

Coal occurs in the bed of the Towa, about eight miles east from Hussingabad. I found many pieces of the same coal near the junction of the river with the Nerbuddah, but they had all been brought down by the stream from the hills, where it is probable extensive beds of this combustible exist: and from the fact of ironstone also abounding there, and the extreme dearness of the metal, it becomes an object to explore the whole surrounding hilly country, and to trace the course of the river, in order to discover the situation of the mineral.

Section II.

Remarks made on a March from Hussingabad to Sangor, and from thence to the Ganges.

The specimens labelled "*From Mulwah,*" were picked up by me on a hasty march which I made from Hussingabad to Sangor, and thence to the Ganges, in my way to this place. I had no leisure to examine the geological features of the country minutely; but the few memoranda which I noted down at the time, defective as they are, may still give some general idea of the nature of the rocks. I shall therefore transcribe them without alteration.

10*th December* 1819.—From Hussingabad, for two or three stages, Sandstone; near the Nerbuddah, singularly elevated towards the east, forming an angle of upwards of 45°, with an abrupt face gradually falling off to the west.

12*th* & 12*th*.—About half way in some of those marches, a rock at the surface, resembling the trap of Baitool, and containing veins of calcareous spar.—Black clay earth in the plains.—Hills of moderate height.—Abundance of agates and chalcedony in this clay soil, and evidently derived from the decomposition of the greenstone rock.

22*d*.—Sangor. The appearance of the rocks to this place continue all the way as already described. At Sangor, however, trap is very abundant, forming large ridges, and mingling with sandstone. On the plain, in front of the cantonments, a conglomerated sandstone, containing fragments of quartz, of a red and grey colour; and in the soil, saw masses of radiated and fibrous calcareous spar.

26*th*.—From Sangor to Huttah, in Bundlecund. Trap twelve miles to Sanonda, first march.—A singular white rock, near Puterea, between that village and Saipore, appears to be flesh-coloured flint, decomposing at the surface. Sandstone at Puterea. Between Puterea and Mirsinghur cross the Sonaur river, the bed of which is grey-coloured compact secondary limestone, apparently of good quality; occasionally schistus, and much mingled with the calcareous rock, particularly as we approach Mirsinghur: this schistus in horizontal layers.

From Mirsinghur, plains showing limestone at the surface, and coarse schistus, with occasional sandstone; farther on, sandstone predominating, and giving the character to the country, in the bleak aspect, and aptitude for the resort of bustards, in this respect resembling the plain at Lohargong.

31*st.*—At Huttah, chiefly limestone. At the cataract on the Sonaur, the arrangement is well seen, consisting of alternate layers of soft schistus and limestone. The limestone very impure, containing fragments of quartz and sand, and occasionally a mineral like felspar. All the way to Lohargong, limestone abundant. Cross the Cane river, from the bed of which I procured the pebbles herewith sent. One or two of these are cut and polished, as finished by the native workmen at Banda.

IV.—*Notices regarding the Fossil Elephant of Scotland.*

By Robert Bald, Civil Engineer, F. R. S. E., M. W. S., G. S. L., &c. &c.

(*Read 24th February* 1821.)

In the observations which I had the honour of reading before this Society, the year before last, regarding the Clackmannanshire Coal-field [*], I remarked, when treating of the alluvial cover which rests upon the rocks, that it consisted of two very distinct kinds, which are termed the Old and Recent Alluvial Covers, and this observation applies to every district of Great Britain which I have examined. That termed Recent, is found along the sides of rivers and lakes, is frequently of considerable extent, generally very fertile, and, along the river Forth, it is in some places 90 feet in depth. It contains great abundance of organic remains, both of the animal and vegetable kingdoms, a circumstance familiar to every observer. This cover is visibly forming and extending every day.

On the other hand, the Old Alluvial Cover is of vast extent, occupying a great proportion of the surface of Great

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[*] Wern. Mem. Vol. iii. p. 123.

Britain; is found at great heights, also under the level of the sea; and is of three kinds, *viz.* 1*st*, Sand; 2*d*, Gravel; and, 3*d*, Clay. The clay is of two kinds, *viz.* 1*st*, fine plastic clay, such as is used by potters; and, 2*d*, clay intimately mixed with sand, gravel, and boulder-stones; which last are sometimes found several tons in weight. It is this last kind of cover which at present I particularly refer to.

I have had very frequent opportunities of seeing this kind of cover laid open from the surface, to the rock on which it rests, and have found it in thickness from a few inches to 160 feet; and have always remarked, that though it contained boulder-stones, and gravel of almost every kind of rock, and detached angular fragments of the adjoining rock-stratification, I never had observed a single instance of an organic remain of any kind in it. This cover is known in Agriculture by the name of Till, and is impervious to water. The soil which covers it is generally thin, and not naturally fertile; of itself, it is indeed one of the most sterile subsoils which is known. The first plant which most frequently strikes root upon it, after exposure to the air, is the common thistle, *Carduus arvensis*.

As the Union Canal, which is now making betwixt this city and Falkirk, passes for 28 miles through a country chiefly composed of this kind of cover, I took the opportunity of noticing if any organic remains were found in it; and I requested my friend, Mr HUGH BAIRD, civil engineer, who directs the canal operations, to be particular in his inquiries if any such remains were found, and to give me notice. Having been frequently along the Canal with him for these last three years, I had an opportunity of investigating the excavations as they proceeded. No appearance of any animal or vegetable remain, however, was found, until the 18th day of July last, when the workmen, who were cutting the Canal, in the west park of Cliftonhall estate, having undermined a large bench of earth, it fell, and a substance, which the workmen conceived to be the horn of an animal, was found amongst the earth, which, as a matter that attracted their curiosity, they laid in a cottage adjoining.

Two days after this, in going along the Canal, I met with Sir ALEXANDER MAITLAND GIBSON, who informed me that a singular remain of an animal had been found in cutting the canal through his estate; and he politely accompanied me to the cottage, that I might see it. On its being produced, I found it to be an ivory tusk, in most complete preservation. After taking its dimensions, and making a drawing of it, I went to the spot where it was found, and questioned the workmen particularly concerning it. According to their information, the spot where it was inclosed in the earth was from 15 to 20 feet from the surface: the earth or cover was of the strong old alluvial earth before described, and at the point where the banks begin to decline, and form the immediate narrow valley through which the river Almond runs. In the upper part of the earth where the tusk was found, I observed fissures about five inches wide at the top, and ending like a wedge below, formed by rents in the clay, and filled with sand. I have, however, reason to conclude, that the tooth had not been in the sand-veins, but inclosed in the clay; for, otherwise, it could not have been in such a complete state of preservation. From the close texture of the clay, and being so impervious to water, the tooth might, I think, have remained for ages in the same state. This spot I afterwards had the pleasure of examining, along with Professor JAMESON, when I pointed out to him the situation where the tusk was found.

The tooth weighed, when washed, 25¾ lb. avoirdupois, and measured as follows:

PLATE IV.

Wern Mem. Vol IV page 61. 64

Fig. 1.

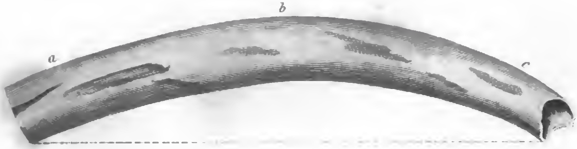


Fig. 2.

SECTION

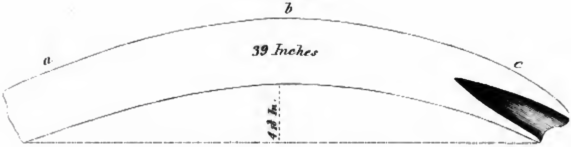
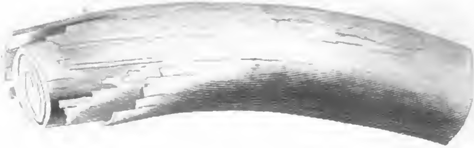


Fig. 3.



W.H.Lizars Sculp.

Length,..................................	39 inches.
Circumference at the middle,...........	13 do.
Circumference at the thick end, ...	13 do.
Circumference near the small end,....	12 do.

And the inside curve deflected from the cord-line 4 inches and $\frac{2}{10}$ths of an inch.

As the specimen interested me much, more particularly as it was the only instance of my having found any organic remain in this kind of cover, I suggested to Sir Alexander Maitland Gibson to take particular care of it. He accordingly told the workman who found it, to send it to the house of Cliftonhall, where he would give him a gratuity for it. The workman, immediately upon understanding that what he conceived to be a horn, was ivory, and very valuable, went off to Edinburgh with the tooth, and sold it. Sir Alexander, the instant he heard of this, went in search of it, and found it in an ivory-turner's, who had given L. 2 for it; but, most unfortunately, before he arrived, it was sawn across in three places, and part of it prepared for the lathe, to form chess-men; which circumstance shews the high state of preservation in which it was found. Sir Alexander repaid the money which had been given for it; and he has, in the most obliging manner, permitted me now to exhibit it to the Society.

It is now five inches shorter than when I measured it, owing to the piece cut out of it by the turner; but I have herewith produced a drawing of it, shewing the exact dimensions when found.

Plate IV. Fig. 1 & 2.

Circumference	at a	13 inches.
Ditto	at b	13 do.
Ditto	at c	12 do.
Depth of hollow	....	7 do.

The air has now begun to operate upon the tooth; it has shrunk considerably, and is formed into longitudinal concentric rings. When first cut across, it was quite solid: this circumstance proves how completely it had been excluded from the action of air or water, otherwise it must have decayed long ago.

I have frequently mentioned to naturalists the observation I had made of no trace of organic remains being found in this kind of cover; and this is the more remarkable, as in the coal-fields, where it rests on rock, the strata abound with impressions, and casts of plants and shells; and the shistus at Cliftonhall abounds with delicate and beautiful impressions of the former. To this observation I have received for answer, that probably both plants and animals may have been at one time in this kind of cover, but are now decayed. Had this been the case, some faint traces of them would have remained, and the clay would consequently have had some of the principles of the fertility of the recent alluvial covers. But this is not the case in the least degree. Besides, from the specimen now exhibited, its quality of preserving organic remains is very manifest.

There are instances, however, where I have seen large trees inclosed in this kind of cover by the sides of rivers: this is easily accounted for. Such trees have grown on the banks of the river: the floods have undermined them, and the trees, after falling, were overlaid by succeeding falls of the bank, and in such a manner as to secure them from either the action of air or of water. Such trees, when taken out, are as solid and hard as when they were growing. I saw an instance lately of an oak-tree taken out of a bank of this kind at Yester, near Haddington; it was very black throughout, and so close in the texture, that it was made into ornamental furniture, which had the appearance of ebony. With this circumstance in view, I examined the situation of the ground where the tusk was found; but it could not, in my opinion, have been covered with earth from a high bank, as it was at the top of the river-bank where the table-land commences.

This specimen being an anomaly in the general observations I have made as to organic remains, I can offer no hypothesis on the subject, nor form any idea as to the period when this tusk had been deposited. We know such specimens are found in a bed of clay in the vicinity of London, but the clay is altogether different from that at Cliftonhall. All these specimens refer to a period very remote, as to which many ingenious theories have been brought forward, without, however, producing any satisfactory conclusion.

As to this old alluvial cover, I am led to think, from many observations, that it has been gathered together by a violent and sudden convulsion; and my chief reason for concluding so is, from the intimate, yet heterogenous mixture of clay, sand, and boulder-stones, while the sharp angular fragments of the soft strata adjoining, such as sandstone, shistus, and coal, shew, that there had been a tearing up of the strata; but the deposit made so instantly, that there was not time for the attrition of these soft fragments. Besides, had it gradually subsided, there would have been traces of beds or divisions in it, and the stones would have been all towards the bottom of it, upon or near the rock head: but this is not the case; large and small boulder-stones are found mixed alike through every part of it. Horizontal beds of sand seldom occur.

The only other instance I know, of elephants' tusks being found in the alluvial cover in Scotland, was in the parish of Kilmaurs, Ayrshire, near the Water of Carmel, in a property belonging to Lord Eglinton. They were discovered in the beginning of January 1817, by Mr Robert Brown, tacksman of the sandstone quarry of Greenhill, while removing the earth above the rock. At the depth of 17½ feet from the surface, he discovered two tusks, one of which measured 3 feet 5½ inches in length, and about 13½ inches in circumference. The other was similar, but so much decayed that it could not be preserved. The alluvial cover was clay; but where the tusks were found, it was much changed in colour, being of a dark-brown, and, when turned up, had a most offensive smell. The colour of the clay, excepting at the spot around where the tusks were found, is of a very light-brown, which rendered the change of colour very distinct.

The tusks were found lying in a horizontal position, with several small bones near them: and it is particularly to be remarked, that several marine shells were found amongst the dark-coloured earth.

The tusk weighed 20½ lb. English weight, and was sent to the Earl of Eglinton. It was afterwards cut through across, and one part of it is to be seen in the saloon at Eglinton Castle; the other part was sent to the College Museum at Edinburgh.* The part which is at Eglinton Castle I have also examined. The exterior is of a brown colour, and very hard; but the greater part of the interior is much decomposed, has lost the ivory texture, and, though not absolutely soft, is similar in appearance to half-rotten wood.

From what I have stated regarding these tusks found at Kilmaurs, we have reasons to draw the following conclusions; namely, That the entire animal had been deposited in the spot where the tusks were found; and that the cover of the rocks, where they were found, was not of the old, but of the recent alluvial cover: the offensive smell, and dark-coloured earth, proved the one point; and the marine shells the other. Hence, the tusk now before the Society, and those found at Kilmaurs, must have been deposited under circumstances totally different, and at periods, in my opinion, very remote from each other.

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* See Pl. IV. fig. 3. (same scale as fig. 1. 2.)

Further, as the dark colour of the earth, and the offensive smell, where the bones were found, support the conclusion that the entire animal had been deposited there; and as we know that, some years ago, the entire body of an elephant was found in a mass of ice in Siberia, and in such a high state of preservation, that the hair remained on the skin,—and the flesh of it, when thawed by the sun, was readily eaten by the dogs,—the hair was short, partly long, and partly woolly, altogether different from that of the present elephants found in Asia and Africa; and as the bones of the elephant are found frequently in the great bed of the London clay, at a considerable depth under the surface, may we not, with reason, infer, that a species of elephant did once exist in northern latitudes, and in Great Britain, whose habits suited a northern climate—and that the tusks found at Cliftonhall and Kilmaurs did belong to this species? This conclusion appears to be still further supported by the fact, that the tusk found at Cliftonhall differs from the present elephants' tusks brought to this country, in having a deep hollow at the small end. This may possibly be accidental; but I am inclined to regard it as characteristic: for, some years ago, I had an opportunity of examining above a hundred tusks of the common elephant, in the possession of Mr JOSEPH GURNEY, ivory-merchant, Sheffield, the whole of which had the ordinary obtuse point, and not one of them presented any hollow at the small end. I may take this opportunity of mentioning, that one of these tusks, which had been sawn across, was very remarkable, having, in the heart of the solid ivory, a leaden musket-bullet, which must have been lodged when the tusk was soft at the root, the animal having been shot at and wounded when young. The ivory around the ball was a little discoloured, and cellular; but there was no opening from the root to the place where the ball was inclosed. The former species, whose habits suited a northern climate, has become extinct, from causes as to which we can form no reasonable conjecture *.

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* To Mr George Johnston, factor to Lord Eglinton, I am indebted for the particulars regarding the interesting fossil found at Kilmaurs. An account of the finding of these tusks was sent to Professor Jameson by Alexander Hood, Esq. surgeon, Kilmarnock, and read before the Wernerian Natural History Society, 20th December 1817.—See Wernerian Memoirs, vol. iii. p. 525.

V.—*Descriptions of Seven New Scottish Fungi.*

By Robert Kaye Greville, Esq. F. R. S. E. M. W. S. &c.

(*Read 29th December* 1821.)

THE number of Fungi hitherto discovered in Scotland is so very limited, that little merit can be claimed for adding a few additional species; yet when a *new* one is ascertained, or one respecting which there exists any degree of confusion, a description of the one, or observations calculated to remove uncertainty in the other, will, it is presumed, be not unfavourably received. Under this impression, I have described several species, which I have recently added to the Scottish Flora. No figures have been published of any of them; one is described by Albertini and Schweiniz in their *Conspectus Fungorum*; and two are so obscurely noticed, that, were it not for colour and locality, I should have no data by which I could judge of their identity.

Since Persoon published his *Synopsis Methodica Fungorum*, in 1801, a great number of Species have been discovered, and many necessary alterations made in the Genera, particularly of the sixth Order, Nematothecii *Fungi* *byssoidei*. The number of genera here has been more than doubled, chiefly by the exertions of the German Cryptogamists; in most instances upon a sufficient foundation, although in some their distinction of specific character seems to be somewhat trifling; as between *Virgaria* and *Haplaria*, *Polyactis* and *Aspergillus*, *Verticillium* and *Botrytis*, *Rubigo* and *Erineum*.

The following plants belong to the order above mentioned, and I have been obliged to adopt the new genera, as no others would receive them; those, however, to which my specimens must be referred, are distinct and satisfactory.

SPOROTRICHUM, *Link*.

Fila ramosa implexa sporis globosis aut ovalibus vage inspersa.

Sporotrichum minutum, *mihi*.

Plate V. fig. 1.

S. subrotundum minutum candidum, filis laxe intricatis sporis numerosis ovalibus.

HAB. In stercore, autumno hyemale.

Small, very white, tufted, sometimes crowded together, tufts about half a line in diameter. Threads under the microscope, loosely interwoven, seldom and irregularly branched, and somewhat attenuated. Sporules oval, or suboviform, very numerous, and not so small as in many species. At Braid Hermitage, on dung.

Sporotrichum tenuissimum, *mihi.*

Plate V. fig. 2.

S. candidum latum telæforme, filis dense intertextis tenuissimis sporis globosis sparsis minutis.

Hab. In ligno mortuo, autumno.

Pure white, and adhering so close to the wood, that, with the naked eye, it was impossible to say whether it was a fungus or a lichen. Very broad, and following the inequalities of the surface on which it grows. Threads very fine, and seldom branched. Sporules round, very minute, somewhat scattered. Found on a piece of dead and rather dry wood, growing chiefly on the bark; Braid Hermitage.

Sporotrichum sulphureum.

Plate V. fig. 3.

S. sulphureum cæspitosum, filis laxe contextis sporis numerosis subglobosis.

Monilia sulphurea? Pers. Syn. Fung. p. 691.
Albert. et Schw. Conspect. Fung. p. 346.

Hab. In stercore et in cellariis, toto anno.

Tufted, roundish, of a pleasant yellow colour, varying in shade according to age. Tufts from half to two lines in breadth. Threads remotely jointed, loosely interwoven, and occasionally branched. Sporules globular, rather numerous.

This plant is by no means uncommon, frequently growing along with the following species, in damp cellars, upon various substances. A short time ago, I received from Dr Brewster a specimen of this and *S. aureum*, growing together on a wine cork; and a few days afterwards, met with them on dung in the neighbourhood of Edinburgh.

I dare not venture to pronounce this plant the *Monilia sulphurea* of PERSOON: his whole character is comprised in the words "*cæspitosa sulphurea;*" and the little use he seems to have made of the microscope, renders the point still more doubtful.

Sporotrichum aurantiacum, *mihi.*

Plate V. fig. 4.

S. cæspitosum aureum, filis tenuissimis valde contextis sporis globosis sparsis minutissimis.

Monilia aurea? PERS. Syn. Fung. p. 691.
ALBERT. et SCHW. p. 363.

HAB. In stercore et in cellariis, &c. toto anno.

Tufted, of a beautiful orange colour, which acquires a reddish tinge in age. Tufts generally about a line in breadth, but sometimes almost confluent. Threads very fine, branched, and much entangled. Sporules globular, scattered, and very minute.

The same degree of uncertainty envelopes this species, as *S. sulphureum*. PERSOON's character is only "*cæspitosa aurea;*" but from the striking similarity of colour, it is probable that both plants are what PERSOON has described with so much brevity, and under the same specific names, under the genus *Monilia*.

It appears very distinct from *S. aureum* of LINK, in the *Berl. Mag.* 7. 13.

PENICILLIUM, *Link.*

Flocci simplices aut ramosi, apicibus dilitatis finduntur in fasciculum, ramulorum capitulum sporarum globosarum colligentem.

Penicillium candidum, *Link.*

Plate V. fig. 5.

P. fila sterilia decumbentia implexa, fila fructifera erecta simplicia subsparsa capitulis sporarum albis.

Penicillium candidum, Link. *in Berl. Mag.* 3. 17. Gray's *Nat. Arr.* v. i. p. 554.*

Hab. In caulibus subputridis plantarum, autumno.

This species forms whitish spots of half to one inch long, by several lines wide, upon the semiputrid stems of herbaceous plants. On these spots the little pure-white heads are very visible to the naked eye, dispersed in a scattered manner over the surface. The threads are simple, erect, and remotely jointed, dividing at the summit into two; and then subdividing into a number of short attenuated ramuli, covered with a profusion of sporules. Sporules round and minute. The barren threads have the same character, except being decumbent, simple to the very summit, and producing no sporules.

This species was found on the decaying stem of *Arctium Lappa* near Edinburgh.

STACHYLIDIUM, *Link.*

Flocci adscendentes basi implexi; ramulis superne verticillatis, abbreviatis obtusis. Sporæ globosæ ad verticillos congestæ.

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* Gray's Natural Arrangement of British Plants, 2 vols. 8vo. 1821,—a most extraordinary work, of great industry, but of less judgment, in which *Jungermannia* alone is split into 19 genera.

Stachylidium candidum, *mihi*.

Plate V. fig. 6.

S. fila ramosa erecta remote articulata candida sparsa sporis globosis.

HAB. Ad lignum mortuum, autumno.

Spreading over rotten sticks and dead wood for an inch or more together, but in somewhat a scattered manner. Under the microscope it is a beautiful object. The threads, which vary considerably in diameter, are remotely jointed, and attenuated at the base. The upper half is regularly verticillate, the whorls being formed by four short and obtuse ramuli; one of these ramuli sometimes becomes a branch, and is then whorled in the same manner. The sporules are small, globular, and collected at the whorls.

BOTRYTIS, *Link*.

Flocci erecti, basi sæpius implexi ramosi, ramulis corymbosis, circum apices sporas globosas colligentibus.

Botrytis diffusa, *Albert. et Schw.*

Plate V. fig. 7.

B. candida ramosa, ramis longe lateque diffusis ramulis undique in racemos dispositis racemuligeris.

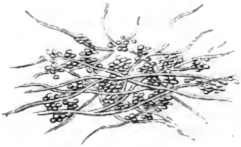
ALBERT. et SCHW. Conspect. Fung. p. 362.

HAB. In caulibus semiputridis plantarum, autumno.

An incomparably elegant and beautiful plant, and much larger than any of its congeners. It forms large spots, of two or more inches in length, of the purest white imaginable, which, when examined, consist of a number of separate tufts, two or three lines in height. The threads are

PLATE V.

Engd for the Wern. Mem. Vol IV. Page 79



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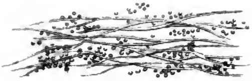

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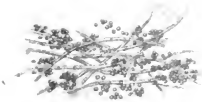

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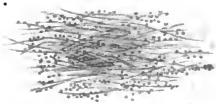

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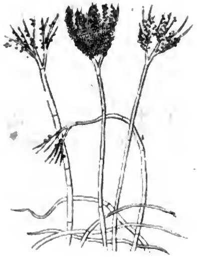

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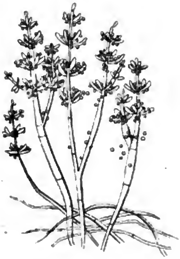

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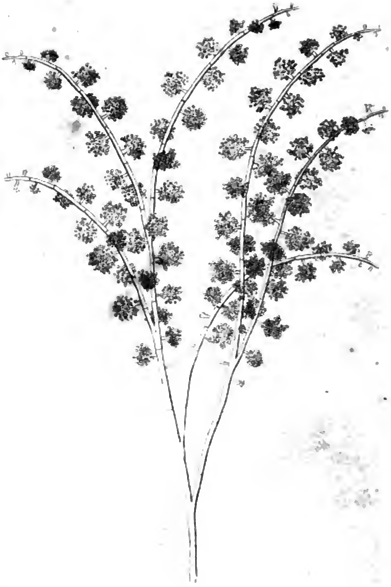

7

R. K. Greville del.

W. H. Lizars Sculp.

naked towards the base, but, immediately after dividing and subdividing into a few branches, become clothed at nearly regular intervals, with small pedicillated clusters of minute globular sporules. After dividing into branches, each thread is continued simple and slender to its summit, and is disposed in the most graceful curve.

My specimens were gathered on a stem of *Arctium Lappa;* those of ALBERTINI and SCHWEINIZ on that of *Solanum tuberosum.*

Edinburgh, December 31. 1821.

Explanation of Plate V.

Fig. 1. Filaments and sporules of Sporotrichum minutum, very highly magnified.
2. Do. of Sporotrichum tenuissimum, do.
3. Do. of Sporotrichum sulphureum, do.
4. Do. of Sporotrichum aurantiacum, do.
5. Do. of Penicillium candidum, do.
6. Do. of Stachylidium candidum, do.
7. Do. of Botrytis diffusa, do.

VI.—*Meteorological Journal, kept at Clunie, Perthshire, for Twelve Years, from* 1809 *to* 1820.

By the Rev. WILLIAM MACRITCHIE of Cluny,
Perthshire.

(*Read* 14*th April* 1821.)

To Professor JAMESON.

Clunie Manse, 15*th February* 1821.

DEAR SIR,

I HAVE been at considerable pains to keep a Register of the Weather here, as exactly, every day, as possible, for the last twelve years. The thermometer was observed regularly at nine o'clock in the morning, and at eleven at night; and the barometer regularly at twelve o'clock noon. The height of both instruments above the sea-level is about 190 feet; and the distance from the nearest point of the German Ocean is about 36 miles on the parallel of latitudes, which is about 56° 35′. Clunie Manse is about 10 miles west of the meridian of Edinburgh, near the foot of the Grampians.

I have sent you herewith a set of Tables, carefully, and I hope accurately, made out from the monthly columns of the Register. In order to shew you, as distinctly as possible, the medium temperature and pressure of the atmosphere here, at the hours of observation, I first took the two extremes of each monthly column of the Register, and adding these together, and dividing their sum by 2, obtained the medium, as you see it marked in the *left* hand columns of the tables for each year. In the next place, that I might ascertain more clearly the medium for each year, I summed up each monthly column with great care, and dividing the sum by the number of days in the month, obtained the medium as you find it marked in the *right* hand columns of the tables for each year. The rest of the tables will explain themselves.

I am, &c.

W. Macritchie.

TABLES

Shewing the Temperature *and* Pressure *of the* Atmosphere, *at Clunie Manse, for Twelve Years.*

	Monthly average temperature, at 9 o'clock A. M., taking the two extremes.	Monthly average temperature, at 11 o'clock P. M., taking the two extremes.	Monthly average pressure, at noonday, taking the two extremes.
1809.			
January	24°½	24°½	29,9°
February	38	39½	29,9½
March	40½	41½	30,2
April	44	38	30,2¼
May	53	45½	30,1
June	57½	49½	29,9
July	61½	53	30,1
August	60½	54	29,8½
September	50½	48	29,8
October	48½	45½	30,1½
November	39	39	29,9
December	33	38½	29,2¾
Yearly aver.	45	43½	29,9½
1810.			
January	35°½	34°	30,0°½
February	36	35½	29,8¼
March	39	34½	29,7¼
April	47½	41	29,8½
May	51½	41½	30,0
June	59½	52	30,0¾
July	59½	52	29,8¼
August	58½	56	29,8
September	55	52	29,9¾
October	48	45½	29,7¾
November	39½	38½	29,8¼
December	34½	35½	29,8
Yearly aver.	47	43⅓	29,8¾

	Monthly average temperature, at 9 o'clock A. M., adding the columns.	Monthly average temperature, at 11 P. M., adding the columns.	Monthly average pressure, at noonday, adding the columns.
1809.			
January	29°½	25°½	29,8°½
February	37¾	37¼	29,9¼
March	42¼	40½	30,2½
April	42½	37½	30,2¼
May	54½	47¾	30,1¼
June	58¼	52	29,9¼
July	61¼	54¾	30,1½
August	58¾	54¼	29,9
September	53½	50	29,8¼
October	49	47½	30,1¾
November	38¾	37¾	30,0½
December	34½	35¼	29,5
Yearly aver.	47¼	43¼	29,9¾
1810.			
January	35°¼	35°½	30,0°½
February	35½	35¼	29,7¾
March	37¼	34¼	29,7½
April	45½	41	29,8½
May	50½	41½	30,0
June	60¼	52	30,1
July	60¼	53	29,8
August	59¾	53½	29,8¼
September	55¾	51	30,0¼
October	47¾	45¼	29,9½
November	39	37¾	29,6¼
December	33	34¾	29,6½
Yearly aver.	46½	42¾	29,8¾

TABLES continued.

	Monthly average temperature, at 9 A. M., taking the two extremes.	Monthly average temperature, at 11 P. M., taking the two extremes.	Monthly average pressure, at noonday, taking the two extremes.		Monthly average temperature, at 9 A. M., adding the columns.	Monthly average temperature, at 11 P. M., adding the columns.	Monthly average pressure, at noonday, adding the columns.
1811.				1811.			
January	33½°	39½°	29,6¾°	January	33¾°	33½°	29,8¼°
February	35	34½	29,6½	February	35½	35	29,4¾
March	44½	41½	29,9½	March	43	39¾	30,0½
April	44½	39	29,7¾	April	45½	41¾	29,8¼
May	54	46½	29,8¾	May	55	47¾	29,8¾
June	60	52½	29,8½	June	59½	51¼	29,4¾
July	63½	55	29,9¼	July	62½	54¾	29,4¾
August	58	53½	29,8½	August	58¼	52½	29,6½
September	54	50	29,8¾	September	54½	50¼	29,4¼
October	48½	49½	29,6	October	51¼	49¼	29,5½
November	41½	41½	29,7½	November	42	42	29,7¾
December	39½	39½	29,6¾	December	34¾	35¼	29,6
Yearly aver.	48	44¼	29,8½	Yearly aver.	47¾	44½	29,6½
1812.				1812.			
January	34°	35½°	29,7°	January	34½°	34°	29,7¾°
February	39	36	29,5	February	38	36¾	29,5½
March	37¼	33½	29,9	March	33¾	34¼	29,8½
April	40½	36½	29,8¼	April	41¾	36¼	29,9¾
May	51	42½	29,9¼	May	50½	44¾	29,8¾
June	63½	52	29,9¼	June	59¼	50¼	29,9
July	59½	52½	30,0	July	58½	51½	29,9¾
August	57½	51½	29,9¾	August	58½	52¼	30,0¼
September	53½	48	30,0	September	54¾	49	29,9¾
October	46½	46½	29,3¼	October	47	46¼	29,5¼
November	39	35½	29,8¾	November	38½	37¼	29,8¼
December	36½	37	30,0¾	December	34¾	35¼	30,0
Yearly aver.	45½	42¼	29,8¼	Yearly aver.	45	42¼	29.8½

TABLES continued.

	Monthly average tempera-ture, at 9 A. M., taking the two extremes.	Monthly average tempera-ture, at 11 P. M., taking the two extremes.	Monthly average pressure, at noonday, taking the two extremes.
1813.			
January	34°	31½°	29°,9
February	40½	39	29,6½
March	44	39½	30,0
April	43	38½	29,9¾
May	50½	45½	29,7½
June	61	50½	30,0¼
July	62½	53½	29,9¼
August	60	53	30,0½
September	53½	50½	29,8¼
October	43½	40½	29,7
November	34¾	36½	29,6½
December	35	35½	29,7½
Yearly aver.	47	42¾	29,8½
1814.			
January	25½°	24½°	29°,6
February	30½	27½	29,7½
March	40½	38	29,7½
April	52½	43½	29,7¼
May	52	43½	30,1¼
June	55	49	30,0¾
July	62½	53	29,8¼
August	59½	54	29.9
September	55½	49	29,9¼
October	44½	43	29,8½
November	37	37½	29,8½
December	32½	37½	29,5½
Yearly aver.	46	41¾	29,8¾

	Monthly medium tempera-ture, at 9 A. M., adding the columns.	Monthly average tempera-ture, at 11 P. M., adding the columns.	Monthly medium pressure, at noonday, adding the columns.
1813.			
January	32¼°	32¼°	29°,9¾
February	38¾	38	29,5¼
March	43½	40½	30,0
April	45½	40¾	29,9½
May	51¾	45½	29,7¾
June	61	50	30,0½
July	62¼	55¼	29,8¾
August	61¼	52	30,0¾
September	54½	51½	29,9¾
October	43¼	41¼	29,7¼
November	36½	36¼	29,6¼
December	36	36	29,8
Yearly aver.	47¼	43¼	29,8½
1814.			
January	27¼°	25½°	29°,6¾
February	34¼	32½	29,9½
March	37¾	35½	29,8¼
April	49½	44½	29,7¾
May	54¾	43	30,0¾
June	57	48¼	30,0½
July	61¾	54¾	29,5½
August	59½	56	29,8¾
September	55½	49¾	30,0½
October	45¾	43	29,7¼
November	39	38	29,6¾
December	34¾	35¾	29,6¼
Yearly aver.	46½	42¼	29,8¼

TABLES continued.

	Monthly average temperature, at 9 o'clock A. M., taking the two extremes.	Monthly average temperature, at 11 P. M., taking the two extremes.	Monthly average pressure, at noonday, taking the two extremes.		Monthly average temperature, at 9 A. M., adding the columns.	Monthly average temperature, at 11 P. M., adding the columns.	Monthly average pressure, at noonday, adding the columns.
1815.				1815.			
January	31°	29½°	29°,9	January	32¾°	33°	29°.9¾
February	40	40	29,7¾	February	35¼	34	29,6¾
March	41½	39	29,7¼	March	41½	38¾	29,6¼
April	44½	42½	29,9	April	46¼	42	29,9¼
May	58½	48	29,9½	May	54	48	29.8¾
June	60½	52	29,8¼	June	58½	51½	29,8
July	62½	54½	29,9	July	61¾	53½	29,9¾
August	61½	55	29.8¼	August	60½	53¾	29,7¼
September	58	49	29,8	September	55¼	49¼	29,8¾
October	48	43	29,7½	October	48	45½	30,0¾
November	40	42	29,6	November	36¼	37¼	29,9¼
December	30½	28¼	29,5¾	December	33	31¾	29,9¼
Yearly aver.	48¼	43½	29,8	Yearly aver.	46¾	43¼	29,8½
1816.				1816.			
January	30½°	30°	29°,4	January	33¼°	33¼°	29°,2¼
February	30	32½	29,7	February	34	33½	29,7¼
March	36½	30	29,6¼	March	36½	34¼	29,6½
April	42	38	29,6¾	April	42¼	38	29,7
May	47½	41½	29,7½	May	49¼	44	29,8
June	57½	48	29,7	June	56¼	49¼	29,8¼
July	59	53½	29,5	July	54¾	52	29,6½
August	54½	49½	29,8¾	August	57¼	51¾	29,8½
September	52½	47	29,5¼	September	52¾	47¼	29,7½
October	45	43	29,8	October	45¾	44	29,7½
November	37½	36½	29,7½	November	37¼	36¾	29,6½
December	31½	31½	29.6½	December	32½	33	29,5¾
Yearly aver.	43¾	40	29,8	Yearly aver.	44¼	41½	29,6¾

TABLES continued.

	Monthly average temperature, at 9 A. M., taking the two extremes.	Monthly average temperature, at 11 P. M., taking the two extremes.	Monthly average pressure, at noonday, taking the two extremes.		Monthly average temperature, at 9 A. M., adding the columns.	Monthly average temperature, at 11 P. M., adding the columns.	Monthly average pressure, at noonday, adding the columns.
1817.				1817.			
January	39°	38°½	29°,5	January	39°½	37°¾	29°,5
February	40½	41	29,8¼	February	40½	41½	29,6¾
March	37½	35½	29,9½	March	38½	36	29,6
April	46	39½	30,1¾	April	47½	42¼	30,2¼
May	50	44	29,7	May	49½	42½	29,7½
June	62½	58	29,6½	June	58½	54½	29,7¼
July	59	52	29,6½	July	58¾	52¾	29,6¼
August	56	49½	29,6	August	53½	50¾	29,5¾
September	50½	49½	29,3¾	September	50¾	49¼	29,9
October	41	38½	29,6	October	42½	38¼	30,0
November	41½	40½	29,8	November	43½	43¾	29,9¼
December	34	31½	29,3	December	32¾	33¼	29,4¾
Yearly aver.	47	43¼	29,7	Yearly aver.	46¼	43½	29,7½
1818.				1818.			
January	37°½	33°½	29°,6	January	36°¼	34°½	29°,5
February	28½	30½	29,4¾	February	33	33	29,5¼
March	39	38	29,3	March	34½	35¾	29,3¼
April	43½	39	29,9½	April	42	37½	29,8
May	52	49½	29,9	May	54	48	29,8½
June	63	60	29,8½	June	62¼	59½	29,9
July	64	57½	29,9¼	July	63	52½	29,9¼
August	60	54	29,8½	August	60	53	30,0
September	55½	47½	29,8	September	54	49¼	29,6¾
October	51½	49	29,7½	October	53	49¼	29,7½
November	42½	44	29,6	November	46	46	29,7¼
December	36	39	29,9½	December	37¼	37	29,9½
Yearly aver.	48¼	45½	29,8	Yearly aver.	48	44½	29,7½

TABLES continued.

	Monthly average temperature, at 9 o'clock A. M., taking the two extremes.	Monthly average temperature, at 11 P. M., taking the two extremes.	Monthly average pressure, at noonday, taking the two extremes.
1819.			
January	36°	39½°	29°.5¾
February	34½	33	29,5
March	43½	41	29,6
April	46½	42½	29,7¼
May	53½	43½	29,8
June	57	50	29,7¼
July	63½	54½	29,8¼
August	65½	57	29.6¼
September	53	51	29,8¼
October	45	44	29,8½
November	36½	33	29,7
December	33	29	29,7¼
Yearly aver.	47¾	43¼	29,7
1820.			
January	26°	28°	30°,0
February	39½	39	29,9
March	42½	38½	29,6½
April	49	42	29,9¾
May	55	46½	29,7
June	61	54½	29,8¼
July	63	54	29,7
August	58½	52	29,7
September	53½	49½	29,7
October	42½	42	29,6
November	38½	40	29,9½
December	40½	41¼	29,9½
Yearly aver.	48	44¼	29,8¼

	Monthly average temperature, at 9 A. M., adding the columns.	Monthly average temperature, at 11 P. M., adding the columns.	Monthly average pressure, at noonday, adding the columns.
1819.			
January	37°	36½°	29°.5¼
February	36¼	35½	29,4¾
March	43	40½	29,8
April	46½	41¾	29,7¾
May	52¾	46¼	29.8¾
June	53¾	49½	29,7½
July	61¾	55¼	29,9½
August	63¾	58½	29,9¾
September	54½	50¾	29,8¼
October	46¾	43¼	29,7¾
November	34½	34½	29,7
December	31¼	30¾	29,6¾
Yearly aver.	46¾	43¾	29,7½
1820.			
January	28¾°	29¾°	29°,8¼
February	37½	36¾	29,9¼
March	40¾	38	29,8
April	48¼	43	29,8
May	55¾	43½	29,6½
June	59	51	29,8¾
July	62¼	54¾	29,9
August	58¼	53	29,7
September	54	48½	29,8½
October	45¼	42	29,5¾
November	40¼	39¾	29,8¼
December	37¾	37½	29,9¼
Yearly aver.	47¼	43	29,8½

TABLES concluded.

Years.	Medium temperature, *per ann.*, at 9 A. M., taking the extremes.	Medium temperature, *per ann.*, at 11 P. M., taking the extremes.	Medium pressure, *per ann.*, at noonday, taking the extremes.	Years.	Medium temperature, *per ann.*, at 9 A. M., adding the columns.	Medium temperature, *per ann.*, at 11 P. M., adding the columns.	Medium pressure, *per ann.*, at noonday, adding the columns.
1809	45°	43½°	29°,9½	1809	47¼°	43¼°	29°,9¾
1810	47	43¼	29,8¾	1810	46½	42¾	29,8¾
1811	48	44¼	29,8½	1811	47¾	44½	29,6½
1812	45½	42¼	29,8¼	1812	45	42¼	29,8½
1813	47	42¾	29,8½	1813	47¼	43¼	29,8½
1814	46	41¾	29,8¾	1814	46½	42¼	29,8¼
1815	48¼	43½	29,8	1815	46¾	43¼	29,8½
1816	43¾	40	29,8	1816	44¼	41½	29,6¾
1817	47	43¼	29,7	1817	46¼	43½	29,7½
1818	48¼	45½	29,8	1818	48	44½	29,7½
1819	47¾	43¼	29,7	1819	46¾	43¾	29,7½
1820	48	44¼	29,8¼	1820	47¼	43	29,8½
Average for the 12 years	47¼	42¾	29,8$\frac{8}{12}$	Average for the 12 years	46$\frac{16}{212}$	43$\frac{10}{12}$	29,8½

The lowest fall of the barometer, here, during the twelve years, was on the 5th of March 1818, at noonday;—the thermometer, at that hour, stood at 42°; very high wind;

	Inches.	Lines.
—the barometer at	28	1
The highest rise of the barometer was on the 8th January 1820, ...	31	0
Hence the greatest range of the barometer for the twelve years, ...	2	9

The warmest day during the twelve years was the 12th of June 1818, when the thermometer stood at 84½°. The coldest day during the twelve years was the 18th January 1820, when the thermometer fell, before sunrise, to zero, and at 10 o'clock A. M. rose to 7°. Hence the greatest range of the thermometer in the shade, here, during the twelve years, was from zero to 84½°.

Table denoting the Course of the Winds, and the Number of Days during which each Wind prevailed.

Years.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
1809	11	52	54	28	6	76	57	81
1810	12	47	56	33	5	65	58	89
1811	18	32	57	31	9	106	35	77
1812	25	57	34	38	7	80	29	96
1813	10	57	14	33	6	102	27	116
1814	7	76	24	33	9	107	30	79
1815	13	31	37	38	9	93	47	97
1816	5	60	46	28	9	67	55	96
1817	11	45	22	40	9	91	51	96
1818	7	35	26	52	9	114	46	76
1819	22	39	24	33	12	89	56	90
1820	17	40	46	23	11	82	59	88
Total number of days	158	571	440	410	101	1072	550	1081

N. B.—NE. means that the wind blew so many days from some one or other of the intermediate points from N to E., and so of the others.

Table shewing the Fall of Snow in Inches.

Years.	Months.	Depth of snow in inches.	Total depth of snow in inches.	In the years	Years.	Months.	Depth of snow in inches.	Total depth of snow in inches.	In the years
1809	Jan.	21½			1815	Jan.	12		
	Feb.	15½				Mar.	1½		
	Dec.	4½	41½	1809		Dec.	14	27½	1815
1810	Jan.	5½			1816	Jan.	7		
	Feb.	3				Feb.	6½		
	Mar.	2¼				Mar.	17		
	Dec.	6	16¾	1810		April	2		
1811	Jan.	1½				Nov.	10		
	Feb.	8				Dec.	18	60½	1816
	April	1½			1817	Jan.	5½		
	Nov.	½				Feb.	4		
	Dec.	2	13½	1811		Mar.	3		
1812	Feb.	4½				Oct.	1		
	Mar.	7				Nov.	3½		
	April	2				Dec.	3	20	1817
	Dec.	½	14	1812	1818	Jan.	15		
1813	Jan.	6				Feb.	5½		
	Feb.	1½				Mar.	8	28½	1818
	Mar.	2			1819	Jan.	1½		
	April	5½				Feb.	1½		
	Nov.	½	15½	1813		Nov.	3½		
1814	Jan.	7				Dec.	10	16½	1819
	Feb.	11½			1820	Jan.	7		
	Mar.	8				Feb.	0½		
	Nov.	1				Mar.	3		
	Dec.	6½	34	1814		Dec.	3	13½	1820

There is no Rain-gauge at Clunie, and the place is not very favourable for one.

General Table of the Weather.

Years.	Number of Fair Days for each Year.	Number of Foul Days for each Year.	Number of Sunshine Days for each Year.
1809	271	94	89
1810	282	83	146
1811	232	133	114
1812	232	134	124
1813	267	98	163
1814	236	129	136
1815	229	136	159
1816	221	145	140
1817	209	156	98
1818	210	155	121
1819	219	146	126
1820	224	142	122
Total	2832	1551	1538
Yearly aver.	236	129¼	$128\frac{2}{12}$

The Fair days include the Sunshine days; and by the Foul days is meant, that, in every one of them, more or less of rain, hail, or snow, fell.

Table of Phænomena which occurred during the Twelve Years.

Years.	Solar Haloes.	Lunar Haloes.	Parhelions, or Mock Suns.	Waterspouts.	Bright Aurora Borealis.	Thunder-storms.	Earthquakes.	
1809	3	8	—	—	—	—	1	The 9th January, at 6 A. M.
1810	2	5	3	1	—	—	—	Lunar rainbow, 29th August, at 10 P. M.
1811	4	9	7	—	—	—	—	
1812	10	1	11	—	—	—	—	
1813	2	2	2	3	2	—	—	
1814	3	3	—	1	3	—	—	
1815	—	2	—	—	—	—	—	Bright lunar rainbow, 14th December, at 11 P. M.
1816	1	2	—	—	1	—	1	The 13th August, at 11 P. M.
1817	—	2	3	—	2	3	—	
1818	7	5	1	—	1	—	—	
1819	5	2	2	—	7	1	—	
1820	—	1	—		3	—	—	

VII.—*A Description of a New Species of Grimmia, found in Scotland.*

By ROBERT KAYE GREVILLE, Esq. F. R. S. E.
M. W. S. &c.

(*Read 12th January* 1822.)

GEN. CHAR. *Seta* terminalis. *Peristomium* simplex e dentibus 16 integris vel perforatis (rarissime fissis) æquidistantibus. *Calyptra* mitriformis. HOOK. *Musc. Brit.* p. 36.; et *Musc. Exot.* p. 9.

GRIMMIA LEUCOPHÆA.

Grimmia caule breviusculo, subramoso, foliis ovatis, longe piliferis, incanis, nigrescentibus; seta exserta, brevissima, recta; capsula ovata, dentibus brevibus perforatis, operculo obtuso-rostrato. Pl. VI.

HAB. In rupibus prope Edinburgum ad locum *King's Park* dictum.

Planta cæspitosa, incana, saxa sæpe latissime tegens; in ætate valde nigrescens.

Caules breviusculi, erecti, subsimplices, laxe cæspitosi.

Folia laxe imbricata, erecto-patentia, atro-viridia, ovata, concava, nervo ad folii summitatem evanescente; *pili* superne longissimi (folia duplo vel imo triplo longior), inferne breves, aliquando subnulli.

Seta exserta, recta, brevissima.

Capsula ovata, rufo-fusca, rarè summitate pilorum foliorum altior, ore annulato.

Operculum brevi-rostratum obtusum.

Peristomium breve, e dentibus 16 intense rufis perforatis.

Calyptra mitriformis, acuminata, inæqualiter fissa.

" Numerous are the species," says Dr Hooker, in his Musci Exotici, " (if such they may be called), of Grimmia, bordering upon *G. ovata* and *pulvinata*, differing from each other in the various modifications of the leaves, the fruit-stalk, the capsule, and the operculum." The species I have just described must be added to the number of this nearly allied series; but I flatter myself, that, in *G. leucophæa*, there are such striking marks for discrimination, that no confusion can possibly arise in regard to its future identity. It ranks along with those species which have piliferous terminations to the leaves, and an exserted and erect fruit-stalk. They are few in number, even including varieties, and such are not described by Bridel or Schwægrichen. If we then separate those which have lanceolate and subulate leaves, it will be found that there are only two with which the least confusion is likely to originate: viz. *G. campestris* of Burchell, Hook. *Musc. Exot.* Tab. cxxix., a native of the Cape of Good Hope, where it grows in dry places on the ground; and *Campylopus lævigatus* of Bridel, *Meth.* p. 76, which was found, in 1806, near Rome, and has since been detected in Switzerland.

Upon an accurate examination, essential differences are perceived; the leaves of *G. campestris* are much broader than those of our plant, and the piliferous terminations much shorter; the teeth of the former are rather long, and are "pretty regularly cleft for nearly half the way down from the apex;" in the latter they are short, never cleft, but perforated, or entire. In Mr Burchell's plant, the *seta* is so much exserted, as to convey the base of the capsule considerably above the diaphanous points of the leaves; in ours, the *seta* is so short, that the capsule rarely rises above them, but more commonly the diaphanous points are on a level with the mouth of the capsule.

With regard to *Campylopus lævigatus*, it would not be easy to determine, from Bridel's character, its precise relation to our plant, or whether indeed it be the same; in many points they appear to agree; but "*pedunculis subarcuatis*," and "*folia erecta*," render the identity very suspicious, and, if his character be correct, must keep it distinct.

I have received from Mr Arnott a plant, which he obtained from the Herbarium of Palisot de Beauvois, marked *Grimmia obtusa?* or *G. Doniana?* It is certainly neither species, but accords more nearly with *G. leucophæa*, except in the teeth, which bear a greater resemblance to those of *G. campestris*, and are like them frequently divided almost half way down from the apex; in being rather more branched, and having the seta somewhat longer than in our plant; so that, after all, it may be said to be intermediate between *G. campestris* and *leucophæa*.

Before the capsules arrive at maturity, the leaves of *G. leucophæa* gradually assume a blackish hue; which, contrasted with the hoariness arising from the long silvery terminations of the leaves, gives an appearance to the plant that belongs not to any other, particularly when viewed covering a large surface of rock.

This species had for some time been mistaken for *G. ovata*, and, without examination, I sent a quantity of it, under that name, to Mr HOBSON of Manchester*, who returned me an answer, denying that it was *G. ovata*, and suspecting it to be *pulvinata;* an attentive examination produced the above result. It has not yet been detected in any other place, which is the more extraordinary, on account of its great abundance in the King's Park.

Explanation of Plate VI.

Fig. 1. 1. Plants, natural size.
2. A plant magnified.
3. One of the upper leaves do.
4. One of the lower leaves do.
5. A capsule do.
6. Operculum do.
7. Three teeth of the peristome do.
8. Calyptra do.

Edinburgh, January 6. 1822.

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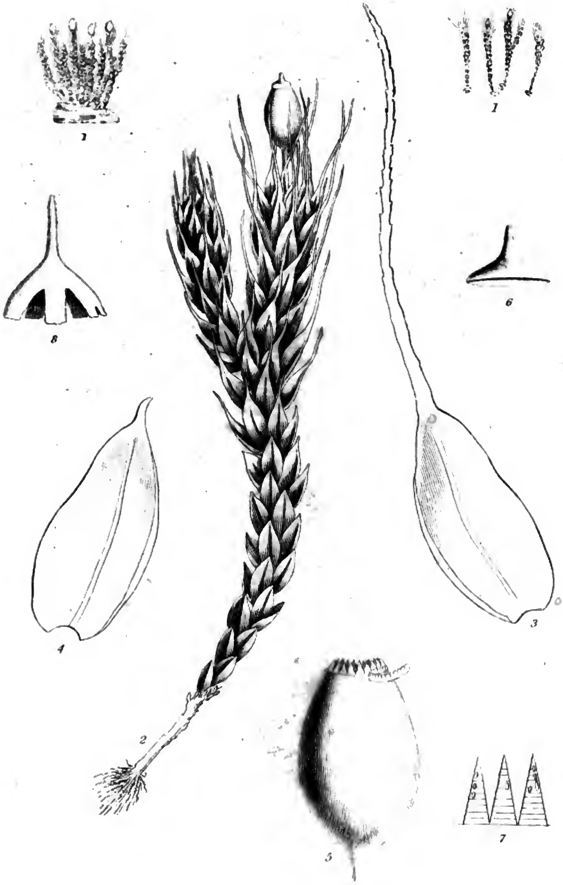
* The author of "MUSCI BRITANNICI, a collection of British Mosses and Hepaticæ, systematically arranged," &c., a work now going on, and which ought to be in the hands of every muscological student.

PLATE VI.

Wern. Mem. Vol. IV. page 90.



R K Greville del^t

GRIMMIA LEUCOPHÆA.

W H Lizars sculp^t

VIII.—*On the Geognosy of Germany, with Observations on the Igneous Origin of Trap.*

By Amie Boue', M. D. M. W. S.

In a Letter to Professor Jameson.

(*Read 26th January and 9th February* 1822.)

My dear Sir,

I had long cherished, as you already know, a desire of visiting Germany, that country of true Geology, for the purpose of viewing there the classical points, of retracing the observations already made, and of becoming acquainted with the ideas of the numerous geologists of my native country. That desire has been gratified; and it is with pleasure that I lay before you a short account of the results of my inquiries.

Germany has been visited by so many geologists, and so many parts of that vast empire have been so minutely described, that one might imagine the geologist, in order to acquire a perfect knowledge of the country, had only to compare it with the description in his hand. This had also been my idea; and, indeed, I have to say, that almost all that I have seen is recorded in the annals of science, or is now known to the German geologists. But I found that all had not been described with sufficient accuracy, nor examined from every possible point of view; and, particularly, that the various deposits had not in all cases been properly classified, from ignorance of the true structure of other countries. So that, if I was not a little surprised to find new facts, or neglected appearances, in localities very often visited by geologists, I was, on the other hand, able to replace some deposits in their true geognostical places; and from this kind of review, I learned more than I could have done in travelling over an unknown country.

An ample detail of the numerous interesting points visited during this long journey shall be sent at another time, my object at present being only to lay before you the principal results of my observations in open field, and in public and private collections, and of a friendly intercourse with many eminent men.

As I have seen in this journey all the principal formations of which the crust of the Earth seems to be composed, I shall communicate my ideas on the series of Formations, dwelling particularly upon those which present the most obscurity or interest, and speaking first of the *stratified* rocks, and afterwards of the *unstratified* ones.

I. STRATIFIED ROCKS.

1. *Primitive Rocks.*

The Primitive class seems to contain only two kinds or stratified formations, Gneiss and Mica-slate, of which, even the first predominates in a great degree over the other, (Erzgebirge, Böhmerwaldgebirge, primitive chain between Austria, Styria, and Hungary, and the primitive country of the centre of France). It is yet possible that there may exist some varieties of primitive clay-slate as subordinate beds; but in the whole of Germany, the Clay-slate, taken for primitive, I pronounce to be Transition, and to pass insensibly into Greywacke, (the Hartz, the Frankenwald, the Erzgebirge, the Carpathians, the Mountains on both sides of the Rhine from Bingen to Bonn, &c.)

2. *Transition Rocks.*

The Clay-slate Formation is improperly so called; for this rock, as in Scotland and England, forms only a very small part, or, in other terms, only subordinate masses, in the extensive deposits of a great variety of rocks, produced by the various mixture of quartz, talc or mica, or chlorite. felspar, and a little calc-spar, or limestone. Such rocks are found, for instance, in the Alps of Savoy, on the banks of the Rhine, in the Erzgebirge, the Carpathians, and in the middle part of Bohemia, where these rocks are extremely interesting, by being composed of distinctly aggregated materials, and by their containing many subordinate beds or masses of various clay-slates impregnated with silica, or, in other words, of varieties of flinty slate and Lydian-stone.

To these oldest transition-rocks, succeeds the Greywacke Formation, as, for example, in the Hartz, the Frankenwald, the chain of hills between Silesia, Bohemia, and Moravia. In these two transition-formations, the limestone forms here and there a series of separate deposits, placed on a line parallel to the general direction of the schistose beds; and when these series are numerous, they seem to be, as in the primitive class of rocks, pretty parallel to each other. Sometimes the limestone concretions are very extensive.

3. *Flœtz Rocks.*

The Flœtz period begins with the Old Red Sandstone, (*Grès rouge*). This sandstone is ordinarily red, generally coarse at first, and afterwards finer: it appears often to be chiefly derived from the disintegration of porphyries, syenites, and granites. In it (as in Silesia), under it (Valley of Tharandt, near Dresden), or upon it (in the Palatinate), occur more or less extensively the coal-sandstones, or coal-measures, having some fresh water shells, and sometimes salt and fresh water organic remains, in different parts of the deposit, but never together in the same bed. In some instances, the sandstone of the coal-formation occupies the greatest part of this formation, as in the Prussian and Bavarian Rhine provinces.

Upon this deposit rests the Zechstein, or Magnesian Limestone, or Calcaire Alpin *; for all these denominations, and the deposits which they indicate, are identical, their various masses and their petrifactions being the same. The *Asche* of the Germans, and their Limestone, with Sparry Iron-ore (Schmalkalden), is the Calcaire Alpin of the south of France, near Figeæ, for instance, a locality described long ago by CORDIER (*Journal des Mines*). The Zechstein of the country of Swarzburg, Kamsdorf, Gera, &c. is precisely the Magnesian Limestone, with flustræ, &c. of Sunderland, and also the Calcaire Alpin Magnesien of the south of France. In Germany, the lowest part of this deposit contains ores, which, in France, are found in the uppermost part of the Old Red Sandstone, as at Chessy. And even in Germany, the Weissliegende, or uppermost part of the Old Red Sandstone, now and then contains these ores, (Eisleben). In England, they are perhaps very feebly indicated in the coal-measures.

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* I do not mean by this term the Limestones of the Alps, which have sometimes been so named without sufficient certainty.

On the north side of the Alps, in a part of the Carpathians, and in the Appennines of Tuscany, the Old Red Sandstone, and especially the Coal-formation, is found associated with the First Flœtz Limestone; or, in other words, these two formations alternate with each other. This is very beautifully exemplified in the chain of the Kalenberg, near Vienna. In the Bavarian Rhine provinces, the Zechstein appears also to be represented by beds of Greyish-black Limestone, placed in the Coal-formation, (Obermoschel, &c.)

Your Encrinal Limestone is nothing else than a set of beds of transition-limestone, exactly similar to some of those of the Hartz and the Ardennes. These beds alternate with the undermost part of the Old Red Sandstone, which is in England, as in the Rhine Palatinate, composed in a great measure of coal-sandstones. Indeed this alternation is quite natural, and conformable to the general laws of the succession of formations; which, especially in the floetz series, alternate universally with each other at their point of contact.*

The Variegated Sandstone of the Germans (the Spessart), the Red Ground or Marl, and the *Grès bizarré* of the borders of the Vosges, of Homburg, &c. are one and the same deposit, which is always superior to the First Flœtz Limestone. It seems to me, that it is only in this formation that the great masses of Rock-salt occur, (Chester, Vic, Wiliczka, Comitat of Marmorosh in Hungary, &c.); but salt springs may issue also from some parts of the Old Red Sandstone.

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* For example, the Shell Limestone (Muschelkalkstein), with the uppermost part of the variegated Sandstone, the Chalk with Plastic Clay, the Plastic Clay with the coarse Marine Limestone, &c.

The Second Flœtz Gypsum of the Germans is exactly the same as the Second Gypsum of France, England, and Ireland; the First Gypsum appears wanting in the two last countries.

In Germany, and in the north-eastern and eastern parts of France, we find above the preceding formation, the Shell Limestone (Muschelkalkstein), a very distinct formation of a greyish limestone, having a pretty perfect crystalline texture (Wurtzburg), and sometimes presenting something of an oolitic appearance, (Westphalia, Buckeburg, &c.) The petrifactions which it contains are, more especially terebratulites, pectinites, ammonites, encrinites, and organic remains resembling a kind of isis. In the south-western part of Germany (near Coburg, &c.), and in the Jura chain (Basel), this Limestone becomes a kind of Magnesian Limestone, with siliceous infiltrations, and loses its petrifactions almost entirely. I do not know that there is any deposit corresponding to this in England, although I see it could only be your Lias: but all that I have observed regarding the Lias of England and the northern coast of France, induces me to consider it as the undermost part of the Jura Limestone. Yet it might be that the Shell Limestone (Muschelkalkstein) of the Continent is represented in England by some thin inferior beds of the Lias.

The Jura Limestone of France and Germany corresponds exactly with your Lias, Oolites, Forest Marl, Cornbrash, Limestone, and Clunch Clay. All these various deposits are found in those countries. The Lias abounds in the north of France; the Oolites are found on the northern border of the Hartz, near Hildesheim, and near Goslar;

the Sultmerberg is composed of a very distinct Jura Limetone; the Clunch-clay is very abundant in Westphalia, and in the same part of Germany are found many beds of Marls and Limestones which belong to the Jura. Lastly, the Planerkalk of the north of Bavaria and Swabia, and of many parts of Germany, is nothing else than certain beds of the Jura Limestone, which extend distinctly from Switzerland, through Swabia and Bavaria, as far as Staffelstein and the neighbourhood of Cobourg.

The *Quadersandstein* of the Germans, to which some authors assign a place above the Jura Limestone, I still think occurs under it, and therefore immediately above the Variegated Sandstone.

The Green-sand, the Planerkalk of WERNER, abounds in the northern parts of France; it is found in Westphalia (from Unna as far as Soist, on the borders of the Hartz, near Goslar and Ilsenberg), near Dresden *, in Poland, and nearly all the Planerkalk of the basin of Bohemia belongs to the same formation. It never contains belemnites, seldom terebratulites, and here and there a kind of massive hornstone. In Moravia, France, and Bavaria, it contains a deposit of hydrate of iron. This deposit is everywhere identical with that of England; and near the Hartz, lies upon the Quadersandstein, and under the Coarse Chalk.

The chalk so profusely distributed in England and France, is also pretty frequent in the north and middle of Germany, especially the inferior part or coarse chalk, which has there been often called *Plänerkalk*. It occupies a great part of a sort of vast sinuosity, stretching from

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* The Green-sand of Dresden and the neighbourhood of Meissen contains three or four species of Terebratulites, without striæ, one or two with striæ, echinites, pectinites, bivalves, and teeth of a squalus.

Saltzkotten, near Paderborn, to Bielefeld and Hilter; and extends behind Paderborn as far as the neighbourhood of Herrenhausen and Kreutzkrieg. There it forms, in the undermost part, a true greyish limestone, with nodules of black flint; and, in the uppermost part, it is a whitish marly limestone, with many echinites, belemnites, mytilites, &c. It just re-appears near Hanover and Luneburg, but forms, farther east, pretty extensive hillocks and plains along the Hartz, from Unter-Elbe as far as Quedlinburg. At this last place, the coarse chalk passes insensibly into the true chalk with flint, having belemnites, echinites, terebratulites, &c. in abundance.

The chalk extends also into Moravia, and forms, particularly near Tribau and Lissitz, a pretty extensive range of hills, in which petrifactions are in some places abundant, in others very scarce. Near Blansko, the last point which this deposit has reached, it contains shells resembling ammonites? or argonautes? and small bivalves; and here it covers a coarse sandstone, under which is situated, first, a siliceous rock, containing flint-nodules, echinites, and small bivalves, and, undermost, a white sand (Quadersandstein), with rich deposits of cellular and pisiform brown ironstone (hydrate of iron). This last deposit is only found in three places,—at Olomuczan, and Kuditz, near Blansko, where it lies in hollows of transition-limestone, and at Salhanka, upon gneiss.

To complete the enumeration of localities where chalk is found in Germany, I have still to mention the Isles of Zealand, Möen, Wöllin, and Rugen, and the Lake of Ücker. In many other points of the eastern part of Prussia, it seems to be indicated, or to be but slightly covered, by the following formations, and in Poland it is very widely distributed.

Upon the chalk, the Plastic Clay, or *Argile plastique*, is widely distributed in Germany, especially in the northern parts. Indeed, the greatest portion of that immense track of alluvial country (improperly so called), from the Rhine to Königsberg, belongs to it. It seems only that the coarse marine limestone and first fresh-water formation are almost entirely wanting, and that this clay and these sands are covered by the upper marine sandy deposit of Paris, to which would belong, perhaps, also the granite-blocks, &c. The same will be the case with the great arenaceous deposit of the Bavarian flat country, of the neighbourhood of Vienna, and of the bottom of the immense Hungarian basin: but in these two last localities, the coarse marine limestone is of pretty frequent occurrence.

In the north of Germany, the plastic clay often contains petrifactions; as in the Magdeberg, near Halle; in Lusatia, &c. The brown coal, which occasionally contains earthy gypsum, as at Halle, and, in other places, amber, always freshwater shells, also coleopterous and fresh-water insects, occurs in considerable abundance in the plastic clay in the north of Bohemia and Thuringia; and from the Rhine to Königsberg, geologists have observed, especially in the basins of existing rivers, a series of these deposits; for instance, near Köln, in the valley of the Weser, in Thuringia, below the town of Berlin, and farther to the north-east. In Slavonia, it contains great masses of sulphur; and in Hungary, and at Vienna, small pieces of realgar. The very compact sandstone which this formation sometimes contains, and which often abounds in fragments of flint, is, for example, very well marked near Zeitz, Beuchlitz, Blansko, Carlsbad, and Töplitz, where it contains the quartz-crystals which had once formed a part of the flœtz porphyries of the neighbourhood.

All the pseudo-volcanic products of the Mittelgebirge are owing to the brown coal of this formation.

The Coarse Marine Limestone (Calcaire grossier) occurs very rarely, and in very small patches, in the north of Germany; as, for instance, near Lemgo, in Westphalia, where it contains cucullea, turritella, natica or ampullaria, nucleola, and other bivalves*. I have also seen it with the same shells near Cassel, Dransfeld, Ahlfeld, and Hildesheim.

The First Fresh-water Formation does not occur in Germany, Austria, and Hungary, yet we have seen gypsum in their plastic clays; on the other hand, the coarse Marine Limestone, or, at least, what I take for it, contains, in Austria and Hungary, remains of amphibious, and even of terrestrial animals. Regarding this interesting fact, however, I cannot say more at present.

The Upper Marine Formation abounds in Austria and Hungary, as well as in the north of Germany; but in the two first countries it is often calcareous, and is associated with much clay, and marl, containing a numerous set of petrifactions, many of which are like those described by Brocchi in the Subappennine Hills.

The Upper Fresh-water Formation exists in the basin of Vienna, (Baden, &c.), in Hungary, and in Moravia. In Hungary, near Pest, there is a true fresh-water limestone, with planorbes and lymnei; and in Moravia, near Nicolchitz, it forms, in a valley, a small deposit, like that of Œningen; and the schistose marls contain there only some impressions of aquatic plants and of insects, (Dipteres). A kind of semi-opal also occurs there.

The north of Germany abounds in Calcareous Tuffs.

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* The Nagelfluh of Switzerland belongs probably to various epochas of the Paris formation.

II. UNSTRATIFIED ROCKS.

The Unstratified Rocks, which appeared, among the preceding, as subordinate masses, or immense local deposits, have arrested my attention during this journey; and I believe we are yet very far from knowing, either their origin, or their true geognostic position.

Granite appears to me to exist in the primitive class of rocks, in great hills or domes, and in veins; of the latter of which, some are in connection with those great bodies of granite constituting mountains; others are isolated in the gneiss or mica-slate, in the same manner as the basaltic veins or dikes are in chalk and other rocks. In the great track of primitive schistose rocks of the Scandinavian peninsula, the granite is confined to the gneiss and mica-slate.

In clay-slate rocks, the granites often occur under the form of syenite, and even of syenitic porphyry, their position being the same as that of the granites in gneiss and mica-slate. I have only to observe, that the various syenitic porphyries are pretty frequent in veins or dikes. To these granites belong some syenites in the clay-slate formation between the northern part of Transylvania and Hungaria, perhaps the syenite near Schemnitz, the granites of the Frankenwald, of the Cotentin, and probably many granites of Cornwall and Brittany.

Those granites, which are undoubtedly newer than greywacke, are almost entirely syenites, or syenitic; at least, it seems probable that these rocks are newer than the granites which we find in the clay-slate districts. One of the best examples of this class of syenites and granites is seen in those which cover so great an extent of country from Meissen to Lauban, and which are now known to repose upon greywacke, and to be covered by it, —or, if this be denied, which are situated in greywacke. The granites of the Hartz, of the Thuringerwald, of Westmorland, of the Criffel, the granite near Loch Ken, &c. must be arranged here.

A peculiarity which these granitic masses have, is to be often surrounded, in part, or in whole, with peculiar anomalous rocks called Hornfels in the Hartz, and varieties of gneiss in Scotland. These last rocks are intermixed with the true greywacke, and pass into it.

To these crystalline rocks succeed great deposits of porphyry. These porphyries, in some countries, form a kind of series of alternating masses with the greywacke, as in Cumberland, and in the Fichtelgebirge, where the Felspathic Breccias or Tuffs are particularly very remarkable. In other countries, the porphyries seem to have appeared later, or not to have had that facility of alternating with other rocks; and hence they rise in the form of immense massive hills, as in Schemnitz, Kremnitz, and in many parts of Transylvania, of the north of Germany, and of the middle of France.

In many countries, the porphyries occur in great masses, veins, or even in beds, in the old red sandstone (Silesia). But their appearance in the middle of the coal formation is the most interesting, because in that case we have been enabled to trace their origin. Near Halle, for instance, where such an occurrence takes place, the porphyries appear in beautiful domes, like the Puy de Sarcouy, in Auvergne, which pass through or under the coal-formation, while another portion evidently extends itself above the arenaceous deposit.

It is also curious to observe, in the neighbourhood of these porphyries, the great disturbances of the strata, the alteration of the coal, and the great bodies of singular anomalous rocks, which, notwithstanding that they pass into sandstones, have so little of their appearance, that they receive other names, Claystone Tuff, Lydian-stone, Jasper, &c.; and indeed their varieties are so numerous, that there is no nomenclature large enough for them.

These porphyries of the red sandstone and coal formation are associated with many trap-rocks, which are distinctly pyroxenic or basaltic, although the trap-rocks which accompany the crystalline deposits in the greywacke appear sometimes to be much more difficultly recognised as such. Yet, near Prague, I have seen in transition-slate, beds or masses of well-marked dolerite, having the common igneous accidents in their upper and under part. The same appearance I had also the pleasure of observing in the valley of Triebisch, near Freyberg, in transition clay-slate.

The trap-rocks form in the Floetz Period, as in the Transition, more commonly veins, with, or without, small *coulees*, or a kind of beds, than hills. The *accidents* of the neighbouring rocks are various. I shall only mention here, that, at Planitz, I observed sandstone-slate, or slate-clay, much indurated under the amygdaloid, and besides the amygdaloid contained an immense quantity of pieces of the old red sandstone, so that the whole had pretty nearly the appearance of an extent of mica-slate, with granitic veins, like those of Garviemore. Besides, I have observed there, that a part of the amygdaloid was only an altered sandstone; and, for this reason, many of the amygdaloids do not give pyroxene by the analysis. How such a change can be produced, I do not know; but such is the fact, and every body may see it. I am only astonished that it has not been recorded. Indeed, I can assert, that the Erzgebirge contains many interesting facts, and distinct appearances, which might be adduced in support of the Huttonian theory. Were I not apprehensive of being considered rash, I would mention the appearance of porphyry elevating itself, with various true igneous *accidents*, from below, and out of the claystone and gneiss rocks. It is also ascertained, I can say, that the beds of porphyry described in the gneiss of that country, are true veins, belonging, as would appear, nearly all to the beginning of the Floetz Period; in which there yet appears, as in Zinnwald, a granite, with ores of zinc, and other minerals, which have been erroneously named the very oldest ones. That the metalliferous veins are intimately united with the appearances of these crystalline igneous rocks, I cannot doubt; but, as may naturally be supposed, some of the minerals contained in the veins have got there from above, or have been formed in the aqueous way. The great metalliferous deposits in veins appeared to me to form a kind of net-work. Certainly nearly all that WERNER has said about them is true; but his explanation, by filling up entirely from above, is no longer admissible. When we consider such vast bodies of rock impregnated with ores, as the auriferous transition-porphyries of Kremnitz and of Transylvania; and when we reflect that all the rich mines of Hungaria and Transylvania are in porphyry masses, excepting a single one in greywacke (Verespatak); and when we entertain a strong suspicion that these are igneous products, we will not long be puzzled to comprehend the phenomena. You will probably oppose to the igneous hypothesis the Mercury-mines in the coal-formation; but these also seem to have been produced in the same way, as results from observations I lately made in the Bavarian Rhine provinces. The ores are there contained in small veins in porphyry, or in rocks in contact with such products; and these coaly or arenaceous rocks are almost always indurated or altered in a thousand various ways; but I shall discuss this subject at another time.

In the period subsequent to the Old Red Sandstone, the Basalts have protruded from below, probably at various irregular periods, even before the formation of chalk; for the cones, hills, and veins of basalts, so well known around the Meissner, Eisenach, the Rhonegebirge, and Göttingen, seem to indicate such an age. But this is a point that requires very minute investigation.

Germany possesses a great variety of basaltic deposits, most of which are analogous to those of Ireland, and to the most of those in Scotland. I say most of those in Scotland, because I am now inclined to classify the few hills around Edinburgh, Arthur's Seat, Salisbury-craigs, and such like deposits, with those of Eissenach. These are certainly in Germany the oldest, and they comprehend some conical hills and veins in different parts.

The other basalts in Germany can be divided into those which have been formed under water, like the preceding, and those which have flown in the open air. The first, like the basalts in Ireland and Scotland, posterior to the chalk formation, form conical or massive hills, a kind of platforms, or high plains very little inclined, and veins or dikes. The cones or hills are principally formed of various porphyritic clinkstones, which take, as in the Mittelgebirge and Rhongebirge, the place of the trachyte of other great deposits. The group of Mezen, in Auvergne, presents the same fact, although it was probably formed above the water. The plateaux, or nappes, present the same variety of basalt and tuffs as Ireland and Scotland, and some points in Auvergne, and also the same calcareous and zeolitic substances.

Basaltic veins are very frequent in Germany, and are found in almost all the formations of that country, with all the *accidents*, as in Scotland. The Quadersandstein of the north of Bohemia, and the Shell Limestone (Muschelkalkstein) of the western part of Germany, present beautiful examples of these appearances.

The second less numerous class of igneous rocks which appear to have flown in the open air, occur not only in hills with craters, and with scoriæ, but also in currents. In the south of Germany, in Hungary, and Transylvania, this class is exceedingly well exemplified; for there the trachytes form great and high districts, more or less surrounded by or associated with basalts; for example, near Feldbach, in Styria. In Hungary and Transylvania, they are accompanied also with vitreous rocks, pumice, and great masses of re-agglutinated trachytic, or pumice-rocks, which show, by sometimes containing shells of the Parisian formation, the recent age of these deposits. Such is particularly the nature of these formations in Hungary, where they rest at Chemnitz and Cremnitz upon the transition metalliferous porphyries, and form, as it were, four or five great islands in the middle of that immense basin.

In the other parts of Germany there exist no trachytes, but only basaltic lavas, with scoriæ and craters, or indications of them. Thus there is a very beautiful crater near the Pferde Kopf, in the Rhongebirge; distinct lava-streams are observed in the Vogelsgebirge; at Eger, there are true volcanic scoriæ, and indications of a crater; near Hof, upon the borders of Moravia and Silesia, the Raudenberg is a great heap of red scoriæ, like the Puy de Graveneire, in Auvergne, or in Vivarais; and there is a portion of a crater and small streams of basaltic lava; lastly, even in the Riesengebirge, there is a crater and streams of lava.

I shall now conclude this long letter, by enumerating the characters which appear to me most distinctive of the two kinds of igneous rocks, those formed under, and those formed above the water.

1. The igneous rocks formed under water, at least those posterior to the chalk formation, do not rise into hills of so great a height as those formed above the surface; and, in general, the first class of rocks must have certainly, in all periods, had more difficulty in attaining the same height as the second.

2. The first class produce veins or dikes more easily, and in greater number, than the second.

3. When the first class of rokes form a kind of coulee or stream, these streams seem generally not to unite the length and the small breadth of the streams (coulees) above the water.

4. The rocks of the first class are generally more compact than those of the second.

5. The basalts of the first class are often intimately united with basaltic tuffs, and the porphyries with some kinds of felspathic breccia; an appearance which is almost entirely unknown in the basalts produced above the surface of the water, because in them the small pieces which form the tuffs had been ejected by the volcanoes under the form of rapilli.

6. Rocks with the vitreous character abound much more in the igneous rocks formed above water, than in those formed under it.

7. The igneous rocks formed under water, contain many substances, produced by infiltration, unknown in the other class of rocks, and more frequently also substances produced by sublimation.

8. The basalts formed under water show imbedded, very often, pieces of the neighbouring rock, which are more or

less indurated or altered. Beautiful examples of this I observed in the basaltic cone of Dosenberg, near Warburg, where the rock is full of pieces of the Shell Limestone (Muschelkalkstein); and in the small clinkstone-cone near Banow, upon the borders of Hungary and Moravia, the rock contains great and small masses of clay and sandstone, so much indurated and altered, that they are like the rock of Portrush in Ireland.

9. The neighbouring rocks are rarely altered near the lavas: on the other hand, near the basalts formed under water, these same rocks are very often subjected to various indurations, alterations, and penetrations of igneous gaseous matters.

I am, my dear SIR, &c.

IX.—*A New Arrangement of the Genera of Mosses, with Characters, and Observations on their Distribution, History, and Structure.*

By R. K. GREVILLE, Esq. F.R.S.E. M.W.S. &c.,

AND

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(*Read 23d February* 1822.)

MEMOIR I.

BEFORE we proceed to the definition of the ORDER, we shall offer some preliminary observations on the principal parts, of which we avail ourselves in the construction of generic characters, and the formation of natural groups.

It is well known, that the great distinguishing character between acotyledonous or exembryonate plants, and all other vegetable tribes, is, as the name imports, the absence of any cotyledon in the embryo, or, more properly, the entire absence of the embryo itself. In all cotyledonous plants, stamens and pistils are invariably present: on the contrary, in the acotyledonous orders, they are to all appearance totally absent; and botanists, unwilling that such a want of uniformity should exist in the vegetable world, have spared no labour, and taxed their ingenuity, to discover, in the more imperfect tribes, something at least analogous to such organs. According to the opinions, however, of later physiologists, and in which we heartily concur, it is extremely improbable that acotyledonous plants are furnished with stamens and pistils, and that through their agency the seeds or reproductive sporules are formed.

This idea is corroborated by the common phenomenon which takes place in those cotyledonous plants which rarely bring their seeds to maturity; small bulbs (*gemmæ*), analogous to the sporulæ of the Cryptogamia, are produced in the axillæ of the leaves, which, when they fall off, strike root at any part indiscriminately; thus differing most essentially from true seeds, while the new plant which arises from them is equally perfect. This appears also to have been nearly the opinion that DILLENIUS * entertained respecting the propagation of the Musci, and it has been confirmed in later times by the celebrated RICHARD, and others.

What the organs really are, in the plants under review, which the accurate HEDWIG so well figured and described under the name of stamens, we leave to others to decide; but we cannot help entering our protest against those bodies called Stamina and Pistilla (the young theca) being regarded in a similar light with the same organs in more perfect plants. "Though," says SPRENGEL,† "I have formerly been a zealous advocate for HEDWIG's theory of the Fructification of Mosses, it has nevertheless appeared to me an insurmountable objection, that the supposed anthers can again produce buds and strike roots; which is certainly the case with regard to the disks of *Polytrichum commune*, *Bartrama fontana*, *Bryum palustre*, *undulatum*, *cuspidatum*, *punctatum*, and with those of *Tortula ruralis*. In *Bryum argenteum* we see the buds containing the supposed anthers constantly drop off, strike root, and produce new plants: this I have observed myself times out of number. Still more in point is the experiment first made by DAVID MEESE, of sowing the stellulæ of *Polytrichum commune*, containing merely club-shaped bodies; when he found that plants came up, which in their turn produced fruit. Another excellent naturalist, Dr ROTH, has made similar observations with regard to *Hypnum squarrosum* and *Bryum argenteum*." He afterwards adds, " It is more probable, therefore, that these supposed anthers are mere gemmæ, produced by the superabundance of the juices, and hence surrounded by succulent filaments *."

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* DILL. Hist. Musc. p. 229.

† Int. to Crypt. Plants, Letter xvii. p. 260. of the English edition.

PALISOT DE BEAUVOIS differed from HEDWIG; he affirmed that the theca contained the pollen, and that the columella (his theca) enclosed the sporules †, which were fecundated by the pollen by means of the ciliæ, as they escaped through the orifice at the summit ‡. This opinion our justly celebrated countryman Mr BROWN found no difficulty in refuting, by showing, that what PALISOT supposed to be pollen, was nothing more than a part of the sporulæ, which had been carried into the interior of the columella by the dissecting instrument ||.

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* Int. to Crypt. Plants, p. 262. of Engl. edit.

† Prodrome des cinquième et sixième familles de l'Æthéogamie, p. 4.

‡ Same work, p. 10.

|| Linn. Trans. vol. x. p. 314.

In thus supporting what seems to have been suggested by DILLENIUS, and confirmed by RICHARD, &c., we do not stand singly, having on our side one of the most acute muscologists of which the world can boast. "The more intimately we become acquainted," says Dr HOOKER *, "with the reproductive organs of the acotyledonous or cryptogamic plants, the more apparent is it, in my opinion, that there are no sexes, as in the phænogamous plants, no stamens, and no pistil, nor any thing analogous to them; consequently no true seed, which can only be produced through their co-operation. The structure of the seeds themselves (more properly sporules) tends greatly to confirm such an opinion; there being, in reality, no distinction into cotyledon radicle or plumule; in short, no embryo, any more than there is in the little bulbs seen upon the stalks of the *Onion* tribe, and upon *Polygonum viviparum*, &c., which yet equally produce perfect plants."

That part of Mosses which contains the sporulæ, has been by some termed *capsula*, or capsule; others have adopted the name *theca*, which, on account of the structure differing materially from the capsule of cotyledonous plants, and also somewhat from the similar organ in other acotyledonous orders, we prefer to capsule, being, at the same time, less liable to ambiguity; a circumstance very desirable in the present period, when the great divisions of the natural system are daily becoming better understood, and a peculiar nomenclature for the abstruser departments more and more necessary.

The theca is always unilocular, contrary to the opinion of PALISOT DE BEAUVOIS, who separates *Pogonatum* and *Polytrichum*, on account of the simple and multilocular theca; mistaking the plicæ, or folds, of the columella, found more or less in all the *Polytrichoideæ*, for actual dissepiments. It is also, except in the genera *Andræa*, *Phascum* and *Voitia*, furnished with a deciduous lid or operculum, and the sporulæ are evacuated by the open apex; at its base is sometimes a carnose body, termed an *apophysis*, having externally the appearance of being a continuation of the theca, and liable to be confounded with it; but within, is well marked by the total absence of sporulæ, and by its containing a pulpy mass similar to that which at an early period fills up the cavity of the columella, and surrounds the sporular bag. The theca is generally supported by a fruit-stalk, called a *seta* (*pedunculus*, or *pedicellus*, of some authors), which varies in length from almost a total absence to above three inches, and in structure resembles the theca. The only exception to this fact is found in the genera *Andræa* and *Sphagnum;* the former is, with its small apophysis, sessile on an elongated receptacle; and the latter also, entirely sessile on a highly curious receptacle, resembling a thin section of a cylinder placed transversely upon a peduncle of nearly the same nature as the receptacle itself, and altogether different from a true seta, although like to it in form. The base of the true or apparent seta, it is worthy of remark, is generally furnished with leaves of a different kind from those of the stem and branches; they have received the name of *Perichætial* leaves, and at one time entirely surround the receptacle, seta, theca, and calyptra. The presence or absence of these leaves, has been considered by some authors, as Palisot de Beauvois, as worthy to assist in the construction of genera: thus, *Pogonatum* would differ from *Polytrichum*, *Cecalyphum* from *Dicranam*, &c. to which we cannot assent; for, on this principle, *Andræa nivalis* might even be separated from the others. It may, however, be employed with effect, in the framing of specific characters.

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* Flora Scotica, Pt. 2. p. 1. note.

Within the theca, and attached to its sides and base by a cellular pulp intermingled with very slender filaments, is placed a membrane, which forms a complete lining: proceeding from the stoma, or mouth, downwards, it is continued to the base, when it is reflected upwards, forming a central column, till on a level with the mouth of the theca. This part has been generally denominated a Columella, and is very different from the placenta* in cotyledonous plants, to which it has been sometimes compared†. A bag is thus formed between the columella and that part of the same organ which lines the theca, in which the sporulæ are situated. The whole is closed by a very subtile membranous expansion, stretching between the summit of the lining and the columella, which (although in *Gymnostomum* it is often of a stronger texture), by the maturing of the theca, and separation of the operculum, lacerates, and, in most instances, becomes evanescent‡. On the open apex of the columella is fixed another membrane, more or less of a conical form, and of a somewhat different texture and colour, which, by age, often shrinks to the appearance of a mere lid to its orifice. Sometimes it is more rigid (as in *Splachnum*, *Tayloria*, and *Gymnostomum Donianum*), and is then not unfrequently called an exserted columella. It also, in some instances, adheres closely to the summit of the interior of the operculum (as in *Gymnostomum Hiemii*, and *Hypnum dendroides*), which it raises or depresses, according to the degree of dryness or humidity to which it is exposed. It is this part which we conceive to be the stigma of Palisot de Beauvois, but which we propose to designate by the more appropriate name of *Opercular Membrane.*

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* Brown in Linn. Trans. vol. x. p. 315.

† Those who, in consequence of a fancied analogy, wish to apply to the Mosses the terms used among the Embryonatæ, or phænogamous plants, might, in the language of carpologists, designate the three principal parts of the theca by Epicarp, Sarcocarp, and Endocarp. The sarcocarp almost always dries up, except where it forms the interior of an apophysis, and is then more permanent. It is the endocarp which is turned upwards into the columella; and this affords an additional argument against the columella being regarded in the light of a *placenta* or *trophosperm*.

‡ In Dr Hooker's excellent figure of *Gymnostomum Xanthocarpum* in the Musci Exotici, the membrane which closes the sporular bag is admirably delineated, Tab. 153. fig. 9.——It ought to be observed, that Palisot has described this membrance in the Mosses without a peristome, but denied it to the others.

We have not been able to trace this conical membrane in the *Polytricha,* unless what Mr Brown * mentions as the pulpy continuation of the columella within the operculum be considered as such: but, as he afterwards † remarks, the uniform texture, and exact form of the tympanum or epiphragma, closing the mouth of the theca, remain to be accounted for. To us this epiphragma appears to be very different from, but to supply the place of, the opercular membrane; it adheres, when young, to the summit of the columella, and entirely closes the stoma; then passing to the base of each tooth, is reflected so as to line it to the very apex, thus forming a real membranaceous inner peristome; and,—a structure easily seen, if the epiphragma, of probably any species of the genus, be carefully removed, and placed under the microscope,—the margin will be found to be beautifully split into segments, or ciliæ, equal in number to the teeth. This we cannot but consider, as we have already said, to be a true inner peristome, and the epiphragma or tympanum only an expansion of the membrane, which (as in *Hypnum*) connects the bases of the inner teeth. Very different, indeed, is the structure which Mr James Sowerby first noticed, in *P. subrotundum*, and of which a dissection is given in English Botany, Tab. 1624., as also under the species *alpinum* and *undulatum*. This structure, which has been also observed by Mr Brown in *P. urnigerum*, and a Nepal species of his own, *P. microstomum*, is described by Sir James Edward Smith as an inner peristome; whereas it is nothing more than the transverse membrane which arises from the inner wall, or the lining of the theca, and is connected with the summit of the columella. The true inner membranaceous peristome is remarkably evident in ripe capsules of *P. alpinum*.

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* Linn. Trans. vol. x. p. 318. † Ibid. vol. xii. p. 567.

The membrane to which we have already alluded, as closing the mouth of the sporular bag, there is every reason to suppose, is stronger and more durable in all such as have a naked peristome. Whatever service it may perform in them, the membranaceous expansion of the inner peristome may assist to perform in *Polytrichum*, for the teeth of that genus afford but little protection to the mouth after the operculum has fallen: and although the membrane which closes the sporular bag also exists, something more may be necessary to effect a complete dispersion of the sporulæ, which are obliged to escape by the orifices left between the teeth, by the elevation of the tympanum.

It was not until after a very careful examination that we could determine whether the columella of *Calymperes* was furnished with the conical or opercular membrane. The horizontal epiphragma stretching across the stoma, which, in a young state, much resembles that of *Polytrichum*, induced us to think it could not be present; while, on the other hand, the epiphragma ultimately splitting into teeth, and the depression of the columella without showing any marks of having been attached to the epiphragma, inclined us to the contrary opinion, which, upon farther investigation, proved to be correct. This membrane (*stigmà* of Palisot de Beauvois) is also very difficult to be seen, though always present in *Funaria*. Whence that author's remark, " stigma simple, et non apparent dans la *Strèphèdie* (*Funaria*)."

It is worthy of remark, that in one species of *Calymperes*, which Mr Brown examined, he mentions the membrane as " entirely wanting, or firmly adhering to the inner surface of the operculum, along with which a considerable portion of the columella also separates *;" which considerably favours our idea of the columella being furnished with an opercular membrane, which in this case might have penetrated the centre of the epiphragma, and produced the above mentioned adhesion.

Mr Brown † seems to imagine that the spongy epiphragma of *Calymperes* is analogous to the horizontal membrane which arises from the lining of the theca in many *Gymnostoma*, *Weissia Templetoni*, &c.; thus making it merely close up the mouth of the sporular bag. We regret, however, that our specimens of *Calymperes lonchophyllum* and *C. Palisoti* are not in a proper state for examination; but we can bear witness to the accuracy of that part of Dr Hooker's figure of *C. Gardneri* ‡, in which the membrane is represented as arising from the outer wall of the theca, which is really the case, and must therefore be considered as a true and curiously modified peristomium, bearing no very distant similitude to *Leptostomum*, in one species of which (*L. erectum* of Brown), Dr Hooker figures and describes the membranaceous peristomium as bearing traces of imperfect teeth [*].

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* Linn. Trans. vol. xii. p. 573, note. † Ibid.

‡ Musc. Exot. Tab. 146.

The gradual splitting, in *Calymperes*, of the membrane into the teeth, which are never erect, is admirably calculated to render the dispersion of the sporules more perfect.

We suspect that the lining to the theca, the columella, and perhaps also its terminating membrane, will never be found wanting in any moss, if it be examined at the period most favourable to their development, which must necessarily take place at different ages in different species, but especially in different genera. There are, however, some instances in which the reverse has been maintained. *Andræa* has been denied a lining to the theca [†]. *Phascum serratum*, and some others, are generally declared to have no columella, while there is an evident one in *Ph. rectum* and *Ph. curvicollum*. In regard to *Andræa*, we believe that the lining is present before the theca bursts into its four valves: an operation extremely liable to render a delicate membrane evanescent. With regard to the *Phasca*, the minuteness of the theca in a young state is such, as to render the dissection very difficult: we therefore confess, that we have not by actual observation been able to establish our opinions in this instance; but have little doubt, however, that a columella is truly present; and we conceive that, at an early period, the membrane, which connects it to the lining of the theca, gives way, thus allowing it to shrink to the base of the theca, and from its minuteness to become inconspicuous. The whole genus *Sphagnum* has more than once deceived us by the apparent total absence of this part, and it was not until we had repeatedly examined the theca, before it had emerged from the perichætial leaves, that we clearly ascertained it to possess one occupying a large proportion of the theca, and bearing on its summit the opercular membrane. The appearance it generally assumes in maturity is that of a convex membrane lying across the bottom of the theca, suggesting the idea, that a lining to the base had separated from its attachment, and had been somewhat elevated without laceration.

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[*] Musc. Exot. Tab. 169.

[†] Hooker in Linn. Trans. vol. x.

We have dwelt perhaps rather longer on the columella than we ourselves originally intended. Our excuse must be, that we really consider it to be an important organ, the economy of which is at present involved in obscurity; and we cannot regard it in the same point of view as Mr Brown and Dr Hooker seem to do, however unwilling we may be to differ from two of the most learned authorities of the present day.

Dr Hooker[*] conceives the columella to be "nothing more than the remains of the cellular and pulpy substance in which the seeds have not been perfected, and which, as we may consequently expect, shrinks up into an angular axis or columella." In this passage, as in the following, we conceive the columella to be spoken of generally.

"In some cases," says Mr Brown[†], "the seeds may be formed in a much greater portion of the columella than in others; and it is even not improbable that, in certain cases, its whole substance may be converted into seeds; or, to speak more accurately, that it may produce seeds even to the centre, and that the cells in which they were probably formed may be reabsorbed."

The late Professor Richard was also of the same opinion: "Toute pyxidule (*theca* nobis) est d'abord complétement solide et charnue; mais lorsqu'elle a pris un certain accroissement, sa substance interne se grenèlle finement, se distingue peu à peu du test, et passe enfin à l'état d'une très fine poussière. Assez souvent une portion centrale de cette substance persiste sous la forme d'un axe longitudinal, qu'on appelle *columelle* *."

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[*] Flora Londinensis, New Series, under *Diphyscium foliosum*.

[†] Linn. Trans. vol. x. p. 312.

We do not by any means intend to assert that the sporulæ are not in some cases formed in much greater abundance than in others: this we know to be true. The cellular matter, in which the sporulæ are produced, if any remains, will also shrink, and perhaps adhere to the columella, particularly if the sporules are first formed in that portion of the granular mass nearest the lining of the theca. In many cases, the columella has assuredly little appearance of a regularly formed body, and in some it is scarcely possible to discover it at all; yet when we see the same part constantly exhibiting a beautiful and symmetrical structure in other species, it is surely fair to draw the general inference, that it is not formed by the contraction of the mere debris of the cellulose or pulpy nidus of the sporules; witness the columella of *Gymnostomum Xanthocarpum*, of *G. pyriforme*, and *G. involutum*; the columella of *Dawsonia*, of *Lyellia*, of all the *Polytricha*; of *Tayloria*, *Systylium*, and all the *Splachna*.

The columella is also, in very many instances, evidently tubular, which could not be the result of contraction, but rather a proof of the contrary, at least in the sense of the above named learned Bryologists. We may here, however, repeat what we have stated, when mentioning the apophysis, to be our opinion, that, at an early period, the cavity of the apophysis, columella, and opercular membrane, as well as the interval between the lining and the theca, is always filled up with a pulpy matter. This is beautifully illustrated in *Buxbaumia*, and is what Mr BROWN and Mr TURNER have observed in *Polytrichum* *. This, however, which is quite different from the sporular granular substance, rapidly dries up in some mosses; producing, among other appearances, the curious effect which the apophysis has, in the mature capsules of *Splachnum rubrum* and *S. luteum*. In most instances, however, it is more durable in the apophysis, and is also sometimes permanent in the columella, as in *Polytrichum*, and has then been improperly compared to the placention of seeds in phænogamous or cotyledonous plants.

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* BULLIARD's Dict. Element. de Botanique, edited by RICHARD, p. 67.

Although we have noticed the distinction between the columella and the opercular membrane, to which it is frequently so united as to appear a single body,—and consider the former in the light of a modified continuation of the lining of the theca, we shall, to avoid confusion, still continue to call it a columella, and to use the terms of *absent*, *elongated*, or *exserted*, according as it appears in the mature theca to have subsided, or, taken in conjunction with its opercular membrane, to have remained of undiminished length.

The *stoma* or mouth of the theca is either naked, as in *Gymnostomum* and *Hedwigia*; or, generally, furnished with a series of ciliæ, called teeth (*dentes*); which may be either in a single series, as in *Splachnum*, *Grimmia*, and *Dicranum*; or in a compound or double series, as in *Hookeria*, *Hypnum*, and *Bryum*. In all mosses which possess a peristomium, it arises from the surface of the

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* BROWN in Linn. Trans. vol. x. p. 318.

stoma, or springs from it, within the margin, and a little below the summit of the theca. In the latter case, the teeth are generally more or less connected by a membrane, which not unfrequently arises to a level with the stoma, or even above it. Sometimes all vestiges of the teeth then disappear, thus presenting the aspect of a truly membranaceous peristome, as is seen in *Diphysium*, *Buxbaumia*, and *Leptostomum;* and in such as have a double peristome of regular teeth, the inner one is formed by this membrane, split into a fixed number of attenuated segments.

Sometimes, though very rarely, the stoma is furnished with a dense horizontal epiphragma, not accompanied with teeth (as is the case with the epiphragma of *Polytrichum*), an instance of which occurs in *Lyellia;* or, what is still more curious, is supplied with a pencil of fine capillary ciliæ, as is exemplified in *Dawsonia*. It is remarkable that these ciliæ apparently arise from around the summit of the columella, as well as from the walls of the theca. This, however, will not appear so singular, when we consider that the summit of the columella may nearly fill up the stoma,—and that, in the case of a membranaceous peristome, it is not uncommon for the peristome, or a part of it, to lose its attachment to the theca, and adhere to the periphery of the summit of the columella. This has occurred to ourselves, particularly in *Leptostomum erectum;* and we have little doubt, that what Dr Hooker figures as an elongated columella in several of his new *Orthotrica* is a similar instance [*], thus rendering their affinity apparently more striking to *Schlotheimia* of Schwægrichen: the opercular membrane it will be found is not on the summit of, but in the interior of, the upright one.

There are several other modifications of the peristome, which it is scarcely necessary to mention here, such as occur in *Fontinalis*, *Cinclidium*, *Conostomum*, &c.: they will all be particularly described when we come to treat of these genera *.

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[*] Musci Exot. Tab. 24. 127. and 128.

There is only one other part of which we conceive it proper to make some mention, *viz.* the Calyptra; a membranaceous veil, which is situated upon, and more or less covers the theca. It is the upper portion of what in a young state is the covering of the theca, and which in a short time tears transversely towards its base. From this body, which is either fugacious or persistent, excellent generic characters may be drawn. It is either dimidiate, mitriform, or campanulate; and sometimes, as in various *Orthotrica*, is cleft into numerous, long, narrow laciniæ, or strap-shaped segments: its surface is smooth, or pilose, or even hirsute; plane, striated, or sulcated. In some instances it is furnished at its base with ciliæ, or a kind of lobes, as in some *Encalyptæ* and *Orthotrica*; but though we can scarcely call them adventitious, they appear to be of a more tender texture than the calyptra itself: they are probably portions of the pellicle of the vaginula, or that body of which at an early period the calyptra formed a part, and from which it was torn by the maturing of the theca.

On the other kind of fructification, the small pedicellated and reticulated bodies, described by authors as anthers, and likewise generally enveloped in perichætial leaves, we shall also make no comments in this place, nor even afterwards, unless extremely remarkable, since they are equally difficult to detect, and unsatisfactory when employed as characters.

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* The terms of inner and outer peristome, we think almost unnecessary to change, being as applicable, after the above explanation, as hitherto.

MUSCI.

Def. *Fructification* double; lateral or terminal, and generally surrounded by leaves differing in form from those of the rest of the plant.

I. Theca unilocular, one or four valved, furnished with an *operculum* and *calyptra*. The operculum is either adnate, as in *Phascum*, *Voitia*, and *Andræa;* or deciduous from the mature theca, and then displaying the mouth, or *stoma*, of the latter, which is either naked, or variously furnished with a membrane, or fringe (*ciliæ*, *dentes*). The calyptra, when young, envelopes the theca, but, as it advances to maturity, tears transversely through the middle; the lower portion is then called *vaginula*, and is permanent; while the upper part, or true *calyptra*, accompanies the theca, even when it is raised by a seta or fruit-stalk, and is more or less fugacious, very rarely persistent. Sporules generally very numerous, without spiral filaments, and, with a few apparent exceptions, surrounding a central columella. Columella variously modified, generally cylindrical, sometimes with large longitudinal plicæ or folds, and, in some instances, so expanded at its summit as nearly to close the stoma of the theca.

II. Small pedicellated, reticulated Bodies; they are either enveloped in leaves of a peculiar form, or are entirely naked: in the one case, the whole stem, or *caulis*, is closely beset with leaves; in the other, the leaves become gradually smaller, so as ultimately to disappear considerably below the *capitula*, or little heads, which these masses of fructification form. Both kinds are sometimes present in the same plant; both are endowed with a reproductive power, and are most abundant when the first kind of fructification (the *theca*) is least to be met with.

Veg. "Plants of small size, of a more or less compact cellular structure, readily reviving upon the application of moisture, after being dry; bearing leaves, which are very rarely divided, often nerved, entire, or toothed, or serrated at the margin." The leaves, though sometimes so minute as to be invisible to the naked eye, are never totally absent.

GEN. I. ANDRÆA, *Ehrhart.*

Fructificatio. *Receptaculum* haud pedicellatum, plus minusve elongatum, lineam vel sesquilineam longitudine superans, foliis perichætialibus paulo longius, album, succulentum, vasculosum, cylindraceum, ad basin in bulbilli formam intumescens, ad apicem thecæ apophysin sustinens. *Calyptra* tenuis, pellucens, albida, laxe reticulata, thecam juvenilem obtegens, basi receptaculum summum arcte adnata; demum ut theca evadat, subhorizontaliter et irregulariter disrumpens, valde fugax. *Seta* nulla, thecâ, vel potius *apophysi* ejus oblongâ vel turbinatâ, fuscâ, substantiâ pulposâ impletâ, receptaculum insidente. *Theca* intense fusca, cylindracea, demum subquadrangularis, in quatuor valvas æquales longitudinaliter dehiscens; quæ exsiccatione, apicibus semper operculo connexis, operculoque per valvarum involvescentiam detracto, in semicirculum eleganter arcuatæ. *Operculum* (conjunctorium, Ehr.) minutum, conicum, obtusum, vel thecæ concolor aut albescens. *Peristomium* nullum ob operçulum thecæ valvarum extremitatibus cohærens. *Columella* thecæ fere longitudine, cylindracea, pallide fusca, subrigida. *Sporulæ* minutissimæ, numerosæ, fuscæ, sphæricæ, obsolete reticulatæ.

Char. Diff. *Theca quadrivalvis; valvæ apicibus operculo connexis.*

Fructification. The *receptacle* may be said to be sessile, but is elongated so as to resemble a seta, overtopping the perichætial leaves, until it sometimes reaches the length of a line and a half: it is white, succulent, vasculose, and cylindrical; the base swelling out into a small bulb, while the summit sustains the subturbinate apophysis of the theca. The *calyptra* is thin, pellucid, whitish, and loosely reticulated, adhering, when young, to the top of the receptacle, and then entirely inclosing the theca; it separates early, and is torn transversely in a very irregular manner, the upper portion, or true calyptra, being exceedingly fugacious. There is no *seta*, the theca, or, more strictly speaking, its *apophysis*, which is full of a pulpy substance, being seated on the receptacle. The *theca* is of a deep brown colour, cylindrical in its young state, ultimately subquadrangular, and splitting longitudinally into four equal valves, whose summits are always bound together by the persistent operculum. In dry weather, the operculum is drawn down by a tendency in the valves to become involute, which causes them to be bent outwards, until they almost form a semicircle, and the theca becomes turban-shaped. The *operculum* is small, conical, and obtuse, either similar in colour to the theca, as in *A. alpina* and *nivalis*, or whitish, as in the other two species. There is no *peristome*. The *columella* is cylindrical, nearly equal in length to the theca, pale-brown, and of a somewhat rigid texture. The *sporules* are minute, numerous, brown, spherical, and obscurely reticulated.

Diff. Char. *The theca is four-valved; valves cohering at their apices by means of the persistent operculum.*

Vegetation. The stems (*caules*) are branched, seldom more than half an inch long in two species, while in *A. nivalis* they reach sometimes five or six inches. The leaves are ovate, and, from being more or less suddenly acuminated, pass into lanceolate; a dark-brown, or even almost black, colour is common to them all, yet they are sometimes inclined to yellow. Two of the species have secund leaves, while a third possesses that character only at the summits of the branches: the other, *A. alpina*, has all the leaves erect, or erecto-patent. The order, however, of the distribution of the nerves of the leaves seems to be inverted. *A. alpina* and *rupestris* are entirely destitute of a nerve; *A. Rothii* has a nerve in all, except the perichætial leaves; while *A. nivalis*, in both the perichætial and cauline leaves, is furnished with a very strong one.

Observations. The truly sessile theca seems to ally these plants most strongly to *Sphagnum*, but that is the only point in which they can be said to bear any resemblance to each other. The four-valved theca is a character by which the species of this curious genus may be separated from all other known mosses; and notwithstanding the central columella, the robust habit, the sporulæ destitute of *elateres* or spiral filaments, and leaves (in two species) furnished with nerves, one can scarcely wonder at some of the older Botanists regarding them as *Jungermanniæ*. In a natural arrangement, therefore, they form an admirable link between the Hepaticæ and the Musci.

What we term Theca is very different from what was here so called by Hedwig. According to him, our theca were teeth, and our apophysis his theca: thus directly at variance with **Ehrhart**, who had previously, and most accurately, described them. Both **Hedwig** and **Ehrhart** have, however, we conceive, fallen into an error, by describing the elongated receptacle as a pedicellus or seta. That we are correct in our denomination of these parts, (and we are not the first), is, we think, clearly proved; by the sporules being never found in the apophysis, but always in the cavity formed by the four valves; and by the texture of these parts and that of the receptacle. For those who believe in the *stamina* and *pistilla* of mosses, we may add, that the latter are arranged along our receptacle.

Habitat. All the four species are natives of Great Britain, but are by no means confined to it. Three are common on all the mountainous rocks of Europe; but *A. nivalis* has been detected only on the summit of Ben Nevis in Scotland, and on some of the more elevated of the Swiss Alps. Hitherto none of the species have been found out of Europe, to whose rocks Nature seems to have restricted them.

History. Two of the species were described by **Linnæus** under the names of *Jungermannia alpina* and *J. rupestris*. From the latter, Dr **Mohr** was the first to separate *A. Rothii*, on account of the presence of a nerve in the leaf, a species which is retained (without a figure) by **Schwægrichen**, but excluded by **Bridel** in his "Methodus nova Muscorum," and again reduced under *A. rupestris*, with the (*amended!*) character—"caule simpliciusculo, foliis laxis imbricatis lanceolato-subulatis falcatis secundis, *nervosis*, perichætialibus æqualibus mucronatis," which would almost incline one to believe that he had seen neither the one nor the other. Both species must, however, be kept up. Lastly, Dr **Hooker** has discovered to us, both in Scotland

and Switzerland, *A. nivalis*, the largest, and, *A. alpina* excepted, the most beautiful of the whole. To the full account published by that excellent naturalist, in the 10th volume of the Linnean Transactions, of the four species, we have been greatly indebted, particularly, it will be perceived, in drawing up the characters of the genus. We have therefore followed him in his examinations, but have described nothing that we ourselves have not verified.

The error which LINNÆUS committed (he used to boast that he never employed a microscope), and which he borrowed from DILLENIUS, arose from overlooking the columella; but this would have been corrected in the "Methodus Muscorum" of the younger LINNÆUS, had he not indignantly cancelled the sheet as written by EHRHART, and retained the original descriptions of his father. The genus *Andræa* was, however, established by EHRHART (Ehr. Beyträge, i. p. 15. and 180.): it was retained by HEDWIG in the posthumous work "Species Muscorum," as also by SCHWÆGRICHEN in his Supplement, but both place it next to *Tetraphis*, among the mosses furnished with a peristome; deceived probably by the supposition, that in maturity, the operculum would fall off. This, however, we have stated, never really to separate of its own accord; and, indeed, SCHWÆGRICHEN adds, "Peristomii dentes in speciminibus nostris non satis maturatis emollitis forte conglutinati." He also elsewhere remarks, "Melior forte locus ad muscorum finem *Andreææ* designaretur," where it has been since placed by BRIDEL. But instead of the conclusion, we think the commencement of a system of Mosses is the most appropriate situation for *Andræa*, as it forms a link of union between the HEPATICÆ and the MUSCI; the former of which orders being the least perfect, must consequently precede the latter in a proper natural arrangement; and in such an arrangement of Musci, both *Andræa* and

Sphagnum, each *sui generis*, must, as it were, stand intermediate.

PLATE VII.

Fig. 1. Theca of *Andræa alpina*, before it has separated into four valves. The ragged vaginula is seen at the base of the small apophysis; and towards the bottom of the elongated receptacle are situate the abortive pistilla.

2. Theca of the same, in a dry state. After the sporules have escaped, the columella is seen, and is shorter than the theca.

3. Calyptra of the same.

4. Sporules.

All the figures are more or less magnified.

GEN. II. SPHAGNUM, *Dill.*

FRUCT. *Receptaculum* lenticulare, seu in clypeolum planiusculum horizontaliter dilitatum, albo-fuscescens pseudopedicellatum, pedicello pallidiore, semiunciam ad sexcunciam longo, crasso, siccitate paulum tortili. *Calyptra* pallens " veli albi instar," tenerrima, tunc thecam arcte circumcingens, et thecæ basin adnata, nunc transversim et irregulariter dehiscens; cujus pars inferior, vel vaginula receptaculo adhæret, parsque superior, vel calyptra, proprie dicta, valde fugax est. Nec *seta* nec *apophysis* ulla. *Theca* integra, ovata, globosa, urceolata, aut turbinata, in eadem specie varians; ore amplo; brunneo-fusca, lævis, receptaculum immediate insidens. *Operculum* planiusculum, seu convexum, matutine deciduum, thecæ concolor. *Peristo-*

mium nudum. *Columella* prima ætate, magna, ampla, sed una cum membrana operculari, postea ita deprimitur, ut membranam thecæ maturæ fundum obtegentem simulet, et nulla dicatur. *Sporulæ* vel pauco-angulatæ, superficiebus convexis, imperforatis; vel subsphæricæ reticulatæ.

Char. Diff. *Theca integra in receptaculum sessilis.*

Fruct. The *receptacle* is in the form of a lens, or, in other words, is dilated horizontally into a much flattened oblate spheroid; of a brownish-white colour, and apparently pedunculated, the peduncle being somewhat paler, varying in length from half an inch to an inch and a half, or more, and of considerable thickness,—rather liable to be twisted when dry, and probably a continuation of the caulis or stem. The *calyptra* is of a pale colour, "like a white veil," remarkably tender, at an early period entirely inclosing the theca, and bound to its base at its conjunction with the receptacle, but soon tearing transversely and irregularly through the middle. Its lower part, or vaginula, still continues to adhere to its place of attachment; but the upper portion, or true calyptra, is very fugacious. Neither *seta* nor *apophysis* can be said to be present, the receptacle forming the immediate support to the theca. The *theca* is entire, ovate, globose, urceolate or turbinate; and all these modifications frequently occur in the same species: it is generally widened at the mouth, of a rusty-brown, with its surface destitute of either striæ or sulci. The *operculum* is somewhat plane, or inclining to convex, and similar in colour to the theca, from which it is at an early period detached. The *peristomium* is naked. The *columella* in the young theca is of no small dimensions, but, by the drying up of the pulp which it contains, sinks along with its opercular membrane so low, as to present the appearance of a mere horizontal tympanum, stretching across the interior of the theca, a little way above its base. The columella, therefore, taken with a view to the mature theca, may justly be described as absent. The *sporulæ* are in some cases almost pyramidal, with their sides convex and imperforated; in others, subspherical and reticulated.

Diff. Char. *The theca is entire, and sessile on the receptacle.*

Veg. The stems are for the most part branched, and, from the influence of locality, or other causes, vary in length from one inch to above four feet. The leaves of none of the species are furnished with nerves; in their form they are liable to the greatest variation, passing through ovato-obtuse, ovato-acuminate, lanceolate, into lanceolato-subulate. They are either adpressed or recurved, or perhaps even secund, thus causing the extremities of the leaves to be sometimes obtuse and tumid, and sometimes attenuated. A remarkable pale-yellowish or greenish-white colour, varied in some instances with a tinge of pink, is common to the whole genus. Their texture is also peculiar, being so tender as to render the apices liable to erosion, a circumstance which is aided by the repeated changes of climate, naturally arising from their situation. This erosion has been made a ground for the constitution of species, by Schwægrichen and others; but it is a character which, with Dr Hooker, we consider of no importance, and not even constant to any one, and to which, therefore, we cannot of course give our consent. The reticulation is no less curious, and is sufficient to distinguish this genus from nearly all others; it consists of oblong, longitudinal, flexuose, nearly regularly formed cellules, always interrupted by transverse lines. In one species (*S. squarrosum*) there are also circular lines independent of, and sometimes intersecting the transverse ones, and chiefly situated at the extremities of the long cellules.

The perichætial leaves differ considerably in these plants from the cauline ones, and at an early period totally envelope the theca, scarcely bursting before it has attained its full size. At this time, especially in a dry state, they are remarkably scariose; and from being, as it were, so glued together, as to prevent the form of each being visible, the whole bears no small resemblance to the calyx of some of the *Jungermanniæ*.

Obs. The species or varieties of this genus are easily distinguished from those of all the other known genera. Their nearest artificial affinity is to *Andræa*, from which they are at first sight separated by the entire theca, deciduous operculum, and apparently pedunculated receptacle; which last, combined with the absence of a seta, affords a distinctive mark from another series of allies, the *Gymnostomoideæ*. We have, under *Andræa*, mentioned our reasons for considering the theca sessile: the same apply also to the present genus. We allude to the difference between the apparent peduncle and all true setæ; and for the close followers of Hedwig, to the situation of the pistilla, which are here formed immediately beside the theca, on the summit of what we term the receptacle. But there is another circumstance, which, although we omitted to state under *Andræa*, applies no less to it, than to the genus under consideration. Hedwig, among his definitions, describes *vaginula*—"Membrana tenuissima, pedunculi basin involvens *prima ætate calyptræ continua*;" yet we find him describing both *Andræa* and *Sphagnum* as possessing setæ. But it ought to be remarked, that Hedwig, in consequence of his hypothesis of the constant presence of a true seta, was led to call our vaginula a portion of the calyptra; and, resting on the former part of his definition—"pedunculi basin involvens," and disregarding the latter and more important clause, searched for the vaginula at the base of his seta, and therefore declared *Sphagnum* to be destitute of it. Accordingly, we find that BRIDEL, following up the same most unphilosophical conclusion, separates it from all the other Mosses, and constitutes for it a distinct section, "*Musci Evaginulati.*" Why they did not equally include in this arrangement the former genus *Andræa*, or rather, what it is that in it they term "*vaginula vix ulla*," we really confess we do not comprehend. In both, however, it will be found that the true vaginula, or remainder of the calyptra, "*prima ætate calyptræ continua*," is fixed immediately below the theca, and to the summit of what we and some others denominate the receptacle, or what HEDWIG called the apophysis. We have already taken notice of the peculiar appearance exhibited by the perichætial leaves in a young state, and have now only to add, that, by degrees, as the theca advances to maturity, the caulis or stem is prolonged into the setiform body, which supports the receptacle; thus separating the perichætial leaves, which now become more evidently distinct from each other, and (as is indeed represented in all the best figures of the species) are scattered along it a considerable way:—a circumstance which also militates against HEDWIG's hypothesis of the seta; that body, in Mosses, being always destitute of leaves, and having the perichætial ones situated around its base.

HAB. All the species hitherto described are confined to damp or wet situations. They have been found not only in Europe, but in North and South America; and probably there are few countries in the whole world, which, in the process of time, they will not be found to inhabit. In general, where they do occur, extensive peat or turf bogs, as in Britain, Germany, and Sweden, are found to be almost entirely formed by them.

HIST. DILLENIUS *, who first, in a system of Muscology, constituted this genus, defined it, "Musci genus capsulas uniformes proferentis, quæ capsulæ ab aliis differunt, quod nudæ sint, seu calyptra destitutæ," &c. LINNÆUS, however, finding a calyptra in many of those described, removed several of them to the *Hypna*, and to a new genus of his own formation, *Phascum*,—"Anthera operculata ore ciliata, calyptra caduca minuta," wherein it may be seen he had altered the nomenclature of DILLENIUS. He still, however, kept up, with very little variation, the former definition of *Sphagnum*—"Anthera operculata; ore lævi, calyptra nulla," retaining under it *Sphagnum alpinum* and *S. arboreum*. In the true *Sphagna*, the erroneous definition is accounted for by the remarkably fugacious and delicate nature of the calyptra. That it really possesses one, is now placed beyond a doubt; but it generally falls off at the time the theca emerges from the perichætial leaves; and it is even difficult before that period to remove those leaves without also detaching it.

The two other plants comprised in this genus by LINNÆUS, *S. alpinum* and *arboreum*, have been generally referred, in later times, the one to *Dicranum*, the other to *Neckera;* but in neither is the calyptra of so fugacious a nature, as to apologise for such a mistake even among the early botanists. The only other plant that has been referred to this genus, is one of more recent discovery; *S. Javanense*, or *irridans* of **Bridel**, or *S. clandestinum* of **Palisot de Beauvois**. It has been since removed by **Bridel**, in his "Methodus nova," with much more justice, to *Dicranum*, near *D. glaucum*, under the name of *D. megalophyllum*. The structure of the leaves is not very unlike to *Sphagnum*, from the cellules being crossed with transverse lines; but the cellules themselves are very different, being oblong and quadrangular, and possessing nothing of that undulating character so peculiar to *Sphagnum*. The fructification has never been discovered, unless it be the same as a *Dicranum*, which Dr **Hooker** has observed in Mr **Turner**'s rich Herbarium.

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* DILLENIUS, though this generic name had been previously applied to plants, was the first to restrict it to the Musci.

The genus *Sphagnum*, as it is now universally received, is a very natural one, and therefore liable, like all such genera, to be reduced to too few, or extended into too many species. Two of the present species were figured by **Dillenius**, while **Linnæus** introduced them under α and β of his *Sphagnum palustre*. These were made by **Hedwig** distinct species. **Weber** and **Mohr** added other two, *S. cuspidatum* and *squarrosum*, which last was probably intended by **Hedwig** to come under his *S. latifolium*. **Bridel** described *S. Magellicum*, *compactum*, and *simplicissimum*. Three out of the above enumerated species were first correctly delineated by **Schwægrichen**. It would, however, be useless to trace all the changes that have been made in this genus by different authors. We shall only observe, that **Palisot de Beauvois** added what he conceived to be two distinct species from North America; and **Bridel** has latterly, in his "Methodus nova Muscorum," or fourth part of his "Muscologiæ recentiorum supplementum," enumerated seventeen, with one (*S. simplicissi-*

mum *) the genus of which is doubtful. It is not our intention to state, under these generic characters, what we consider to be good species, or what merely varieties; but we cannot refrain from expressing our opinion, that, notwithstanding the apparent striking difference between some of the *Sphagna*, and the peculiar structure that is exhibited in all the leaves of *S. squarrosum*, which we have examined, it is not improbable, that at some future period the old Linnæan species may be again adopted. We cannot, in this place, do better than give BRIDEL's observations at the end of the genus, in nearly his own words.

"Genus *Sphagnum* inter omnia maxime naturale, proprio Marte stans, nec ulli alteri affine. Ramorum nempe ad caulis latera dispositione fasciculari aliis muscis alienissimâ, foliis semper concavis, integerrimis, areolisque plus minusve trapeziformibus, a cæteris gentis nostræ generibus longe removetur. Unicam insuper speciem diceres, jam innuantibus TREVIRANO et RÖHLINGIO, per varietates multas certos inter se limites non admittentes diductam. A *cymbifolio* et enim, cui forte conjungenda *compactum* et *condensatum*, quippe quæ non aliter quam ramulorum fasciculis approximatis indistinctis ab eo recedunt, mediantibus *tenello* et *patenti*, contra MOHRI assertionem qui transitum talem temere negat, ad *squarrosum* devenimus sese iterum cum *capillifolio* ex habitu arctius connectens, quod a *subulato* et *ericetorum* vix specifice diversum, tandem in *cuspidatum* mediante *pentasticho* abit. Hinc si leviora discrimina a foliorum reticuli areolis majus minusve dilitatis aut coarctatis desumpta negligantur, fatendum est thecæ structuram uniformem et constantem, foliorum formam per gradus intermedios sensim et absque salebra leviter immutatam, ramulorum denique dispositionem in *Sphagno* peculiarem solemnemque unicam speciem in genere unico promulgare videri. Non possumus tamen plures species non admittere potius ex habitu, colore, &c. quam ex ullo charactere firmo, constante genuinoque dignoscendas."

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* We have never observed this species in any of the herbariums abroad that we have visited, unless it be a plant that we received by the kindness of M. B. DELESSERT, from the collection of PALISOT: this, however, which is nearly quite simple, of a pinkish hue, and has leaves broadly ovate and obtuse, we consider only a singular variety of *S. obtusifolium*.

In addition to the above, we have only to add, that we ourselves possess several additional connecting links between the varieties; but that, for the present, we follow **Hooker** and **Taylor**[*] in keeping up the four species, *S. obtusifolium*, *squarrosum*, *acutifolium*, and *cuspidatum*, to some of which all the others (though sometimes, we confess, with difficulty) may be referred: and these, if all are afterwards again reduced to *S. palustre*, will form the types of the varieties.

Plate VII.

Fig. 5. Theca of *Sphagnum squarrosum*, before it has emerged from the perichætial leaves. Some of the perichætial leaves are removed. The ragged vaginula is very evident, springing from the receptacle; as also some abortive pistilla (*Hedw.*)

6. Mature theca of a *Sphagnum*, showing the naked peristomium, and the vaginula and barren pistilla as before.

7. Operculum.

8. A young theca cut open, to show the columella.

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[*] Muscologia Britannica, p. 4.

9. *a*, Spherical and reticulated sporules of *S. squarrosum*. *b*, Deltoideo-pyramidal sporules of *S. acutifolium*. See also SCHWÆGR. Suppl. Tab. 5. fig. 9.
10. A portion of a leaf of *S. obtusifolium*, to show the reticulations and transverse striæ.
11. A portion of a leaf of *S. squarrosum*, showing, besides a variation in the form of the areolæ, curious circular lines of the same nature as the transverse ones.
12. Section of the stem of *S. obtusifolium*.

All the figures are more or less magnified.

PHASCOIDEÆ, *Gen.* (3—4).

CHAR. *Receptaculum haud pedicellatum, sed intra folia perichætialia sessile. Calyptra dimidiata, aut fugax aut persistens. Seta longitudine et colore valde varians. Theca integra non angulata. Operculum persistens obliquum. Peristomium nullum.*

CHAR. *The receptacle is sessile. The calyptra dimidiate, in some very fugacious, in others persistent. The seta very variable with respect to colour and length. The theca entire, and without angles. The operculum persistent and oblique, inclining to rostrate. There is no peristome.*

OBS. We have been obliged to have recourse, more to the structure of the theca, than to any peculiar habit in the plants forming this tribe; indeed there are few genera, with terminal setæ and entire capsules, to which they do not bear some affinity. The above character is therefore

employed, as they cannot assimilate under any other group. The persistent operculum brings them near to *Andræa*, to which in habit they are most remote; and so long as generic characters are taken from the fruit, they must be ever kept separate from all peristomed mosses.

GEN. III. PHASCUM, *Linn.*

FRUCT. *Calyptra* dimidiata, fugacissima, theca in nonnullis paulo brevior, in plurimis minima, tenera, albescens, laxe reticulata. *Seta* terminalis, innovatione interdum quasi lateralis; plerumque brevissima albo-virescens tenera; aliquando tamen, ut in *P. bryoide*, duo ad sex lineas longa, brunnea rigidior. Thecæ *apophysis* sæpius nulla, sed in *P. splachnoide*, monente HORNSCHUCHIO, præsens. *Theca* a setâ decidua, integra, lævis, subglobosa vel ovata; sæpius et interdum eleganter reticulata; brunnea vel brunneo-fusca; quandoque (ut in *P. crassinervio* et *cuspidato*) tunica singulari cincta, tunicâ juniore "crassâ, subcarnosâ viridi-pallida pellucida," maturiore et siccâ calyptram magnam scariosam indehiscentem referente. *Operculum* obliquum thecæ paulo tenerius, nunquam abscedens, sed ita thecam adnatum, separationisque linea tam tenuis, ut operculum nullum, sed thecæ acumen breve, tyro diceres. *Peristomium* nullum. *Columella* dicta valde variabilis; in *P. recto* et *curvicollo* conspicua, prælonga; in plurimis brevior et fere nulla. *Sporulæ* majusculæ tuberculosæ angulatæ; numero variantes, in *P. alternifolio* sedecim tantummodo, in *P. serrato* circiter centum.

CHAR. DIFF. *Theca a setâ decidua; calyptra brevis, fugax.*

FRUCT. The *calyptra* is dimidiate, and very fugacious; in some species, only a little shorter than the theca; in most, however, much shorter, and small in size: it is tender, of a whitish colour, and reticulated. The *seta* is terminal; sometimes apparently lateral, in consequence of innovations; generally short, of a greenish-white colour and delicate texture; sometimes reaching the length of from two to six lines, when it is browner, and more rigid. An *apophysis* to the theca is a rare occurrence, but such a structure has been described by Dr HORNSCHUCH to exist in one species, P. *splachnoides*. The *theca* is deciduous from the summit of the seta, entire, somewhat globose, or ovate, and not striated; generally reticulated, but sometimes most beautifully and regularly chequered with transverse bands: the colour is more or less of a deep-brown; in one or two instances, as in *P. crassinervium* and *cuspidatum*, it is, in a young state, completely surrounded by a remarkable coating of a thick subcarnose, pale-green and pellucid substance, which, when dry, bears a strong resemblance to a large scariose calyptra previous to laceration. The *operculum* is oblique, of a more tender structure than the theca, never deciduous, but so united to the theca, and having the line of separation so inconspicuous, that one would almost be disposed to call it, less an operculum, than a short oblique termination of the theca. There is no *peristome*. The *columella* is here very variable; long, and easily observed in *P. rectum* and *curvicollum*; but in most others, short, or apparently absent. The *sporules* are large for the size of the theca, angled, and tuberculated, varying much in regard to number, being 16 in *P. alternifolium*, and about 100 in *P. serratum*.

DIFF. CHAR. *The theca deciduous from the seta; the calyptra short, fugacious.*

VEGET. The stems are sometimes branched, but in the greatest number of the species extremely short. In *P. serratum* and *cohærens* they are apparently absent, but really present under the form of surculi, or creeping articulated conferva-like shoots, destitute of foliage, upon which the fructification with its perichætial leaves is sessile.

The cauline leaves of all the species are furnished with a nerve, and are in general reticulated. In this character, the perichætial leaves of *P. serratum*, *cohærens*, and some others, are remarkable, the cellules being large, and evident under a small power of the microscope. They vary in shape, from ovate, in *P. curvicollum* and *patens*, ovato-apiculate, in P. *rectum*, to lanceolate and subulate in other species. Their situation is generally along the stem, without any particular order; but in *P. alternifolium* they are beautifully alternate. Serratures are found in some few species, but those with subulate leaves are always entire. The perichætial leaves are for the most part uniform with the cauline ones; but in *P. alternifolium* they are much larger and longer, and surround the theca.

OBS. Two of the species of this genus are apparently at variance with the generic character, P. *alternifolium* and *axillare*; in both, the seta appears to be truly lateral. In consequence of this, BRIDEL has made a new genus of the former, under the name of *Pleuridium*—"Capsula lateralis inaperta decidens, calyptra decidua;" and adds another species, *Pleuridium globiferum*, from the Isle of France, which seems to be merely a variety. In P. *alternifolium*, the theca is, however, really terminal, or, at the summit of small branches, situated on the main stem. It is the shortness of this branchlet which deceived BRIDEL: but an accurate inspection shows, that it is also clothed with cauline leaves, and not with the long perichætial ones alone; the seta cannot therefore justly be said to be axillary. The other doubtful species, *P. axillare*, is more deserving of a place under *Pleuridium*, and indeed **Hornschuch** seems to be at a loss what to do with it; but even here the seta is at first terminal. "Pedicellus primo ortu terminalis, at mox, producto caulis apice, lateralis *."

The *Phasca* can scarcely be said to possess a habit peculiar to themselves. Among those with short setæ, *P. alternifólium* resembles closely the shoots of *Dicranum varium*, while *P. cuspidatum* is frequently passed over by the tyro for barren stems of *Bryum cæspiticium;* those with the setæ exserted, especially *P. rectum* and *bryoides*, approach intimately to some of the *Gymnostoma* and *Weissiæ*, and more especially to what constitutes the following genus.

Hab. These plants are seldom found in lofty situations, but generally on moist banks, and open fields in the low countries. They abound chiefly in Europe; North America, however, possesses some; and the Cape of Good Hope two species, *P. nervosum* and *splachnoides*. We have also seen what we conceive to be a variety of *P. subulatum*, from King George's Sound, New Holland.

Hist. This genus, as we have formerly noticed, was ranked by **Dillenius** under his *Sphagna*, but was separated by **Linnæus**, under its present name. Only two, however, of his species prove to be true *Phasca*, and the remainder have been transferred to other genera. In Britain no more than these two appear to have been known in the time of **Hudson**, but this number was soon increased by the industry of various botanists. DICKSON added several to the British list: Mr TURNER, to whom muscology owes so much, describes nine species as natives of Ireland, in his excellent "Muscologiæ Hibernicæ spicilegium;" and Sir J. E. SMITH, in his "Flora Britannica," and also in his subsequent and more valuable work, the Compendium of the former, enumerates seventeen. Drs HOOKER and TAYLOR, having examined them with the utmost microscopical accuracy, found it necessary in their "Muscologia Britannica*," to reduce that number to eleven. In the mean time, HEDWIG, on the Continent, including a species from North America, raised the original number to twelve. SCHWÆGRICHEN, in his Supplement, describes seventeen; and, latterly, BRIDEL brings as many as twenty-seven species under *Phascum*, and two under *Pleuridium*, thus making no fewer than twenty-nine. Of these it is sufficient to say, that thirteen only can be established as good species. There is, however, one more (*P. Florkëanum*, with an English variety, *P. stellatum*, BRID.), but which, until we see better and more decided specimens than those at present in our possession, we cannot help thinking too closely allied to *P. muticum*, and its varieties,—a circumstance also noticed in the "Muscologia Britannica." Two species, as already mentioned, have been lately added; one by Dr HOOKER, in his beautiful "Musci Exotici," the other by HORNSCHUCH in the "Horæ Physicæ Berolenses;" so that at present only fifteen species can be enumerated of this extremely minute genus.

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* Sir J. E. **Smith**, Flora Britannica, p. 1150.

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* This most excellent work is, we know, out of print; but we hope the public will speedily be favoured with another edition, which cannot but acquire an additional interest with the British muscologist, from the new materials that will enrich it.

PLATE VII.

Fig. 13. Theca of *Phascum curvicollum.*
14. Do. of *P. subulatum.*
15. Calyptra of *P. curvicollum.*
16. Sporules of *P. subulatum.*
All the figures are more or less magnified.

GEN. IV. VOITIA, *Hornsch.*

FRUCT. *Calyptra* dimidiata magna, thecâ paullo longior, persistens; dum basi cohæret, subcylindrica, integra, flavo-fusca, thecâ autem adultâ campanulato-conica, grisea, tenuis, lævis, glabra, altero latere deorsum fissa, sursum vero integra et thecæ tam arcte adglutinata, ut in maturitatem usque persistat, et non, nisi tempestatum et pluviarum injuriis demum exesa, solvetur. *Seta* terminalis, lineas octo ad quatuordecim longa, erecta, lævis, quandoque torta, carneo-purpurascens, "sub theca in discum infundibuliformem solidum dilitata," ex quo theca continuatur. *Apophysis* nulla, nisi discus sub theca prædictus. *Theca* integra, plus minusve ovata, lævis; matura, hinc inde collapsa, spadiceo-fusca, calyptra vestita, nunquam dehiscens, sed una cum operculo suo, basi humore et putredine soluto, decidua. *Operculum* semper adnatum, obliquum, attenuatum, theca texturæ laxioris. *Peristomium* nullum. *Columella* magna, thecâ brevior, oblonga, obtusa, albida, laxe cellulosa. *Sporulæ*, in cumulo griseo-virides, copiosissimæ, compactæ, exiguæ, sphæricæ, læves, tres vel quatuor loculorum vel sporulorum quasi constitutæ.

Char. Diff. *Theca cum seta decidua; calyptra magna persistens.*

Fruct. The *calyptra* is dimidiate, as long, or even longer, than the theca, and persistent; while it is attached by the base, it is nearly cylindrical, entire, and of a yellowish-brown colour; as the theca becomes old, it changes to campanulato-conical, and is of a greyish hue, slender, smooth, unfurrowed, splitting from the bottom upwards on one side, but entire above, and so closely cemented to the theca, that it remains attached till maturity, and is not even then loosened, unless by injuries caused by the vicissitude of the seasons. The *seta* is terminal, from eight to fourteen lines in length, erect, and smooth, but sometimes slightly twisted; of a purplish-red colour, and "dilated under the theca, into a funnel-shaped solid disk," of which the theca is a continuation. There is no *apophysis*, unless the above mentioned disk beneath the theca can be considered as such. The *theca* is entire, more or less ovate, smooth, when mature here and there collapsed and wrinkled, of a reddish-brown colour, and clothed with the calyptra; it is never dehiscent, but falls along with its seta, whose base is putrified and corroded by a superabundance of moisture. The *operculum*, which is, as it were, firmly bound to the theca (from which it differs, in being of a looser texture), is oblique and attenuated. There is no *peristome.* The *columella* is large, a little shorter than the theca, oblong, obtuse, whitish, and cellular. The *sporules*, viewed in the mass, are of a greyish-green colour, very plentiful, extremely minute, spherical, smooth, apparently tri-quadri-locular, or as if three or four smaller sporules were cemented together.

Diff. Char. *The theca falls along with the seta; calyptra large and permanent.*

Veg. In one species the stems are scarcely more than three-fourths of an inch in height, but in the other they reach from two to three inches: they are either simple or branched, and so closely matted together (at least in *V. nivalis*), that it is extremely difficult to separate a complete plant from the mass. The leaves are imbricated, erecto-patent, of a yellowish-green colour, ovate, more or less concave, scarcely acuminate in one, and considerably so in the other species, very entire, embracing the stem at their base, with a strong brown nerve reaching to the apex; their reticulation is large, and nearly rectangular; the perichætial leaves are much more acuminated, tender in their structure, but equally furnished with a strong nerve.

Obs. Few plants are more remarkable than those which form the present genus. Their closest affinity is to *Phascum*, especially *P. bryoides;* but the persistent calyptra of *Voitia*, and what is of much greater importance, the theca, deciduous only along its seta, must for ever keep them distinct; while, on the other hand, the adnate operculum is sufficient to separate them from all other mosses that may resemble them in habit. Among those with which they might at first be confounded, are, the *Encalyptæ* and *Splachna*, and even some of the *Brya.*

Hornschuch, in his "Commentatio de Voitia et Systylio" (from which, by changing the terms, we have borrowed nearly the whole of our description of the fructification), describes the theca of his species—"ovata in acumen subobliquum, truncatulum, pellucidulum attenuata," while he denies it to possess an operculum; so far we do not agree with him, and have accordingly denominated the termination of the theca an Operculum. This is not the result of caprice; for it will be found that the oblique attenuated point is destitute of sporulæ, and that the sporular bag actually terminates at the summit of the ovate portion of the theca, to which, therefore, the term Theca can only be applied. The more pellucid appearance in the acuminated summit, as observed by HORNSCHUCH, was owing to this absence of sporulæ; we therefore consider it as a true operculum. He adds also, that it is of a different texture,—"texturæ laxioris." We shall close these observations with another remark from that learned Professor, but which we ourselves have not been able completely to verify; *viz.* that the vaginula, in this genus, is composed of two valves. In all mosses, at an early period, the vaginula and calyptra are one and the same; the latter is, by the enlargement of the theca, torn from the lower portion, and each part then receives a distinct name, and becomes independent of the other. In *Andræa* and *Sphagnum* this is peculiarly visible; the portion left at the base, now called Vaginula, is generally entire, and it is so in *Phascum.* On this character, the above mentioned commentator lays much stress in his diagnosis of the two genera; but we do not see that it is of so much importance as the points we have already enumerated.

HAB. These plants have hitherto only been found on the summit of the Carinthian Alps and in Melville Island. We have not been able to ascertain whether those brought from the latter place grew upon the dung of animals, as was the case with those discovered by Dr HORNSCHUCH: from our specimens we should rather imagine the contrary.

HIST. Dr HORNSCHUCH was the first fortunate discoverer of this curious genus in 1817, a figure and description of one species of which he published in 1818. An excellent figure is also given by Dr Hooker of the same in his "Musci Exotici," taken from specimens communicated by Dr Hornschuch. This genus, though of such recent discovery, was again met with soon afterwards in a different part of the world, Melville Island; in which some specimens were collected, and from whence they were brought to this country by Captain Sabine, who accompanied Captain Parry in his late adventurous and ever memorable Arctic expedition. Although the quantity from that habitat was small, yet having observed plants of it in the possession of two or three individuals, always retaining the same characters, and having examined our own specimens minutely, we have been induced, on really finding them to differ materially from the plants gathered by Professor Hornschuch, to propose them as distinct species, with the following characters:

1. Voitia nivalis, *caule elongato ramoso; foliis ovato-lanceolatis, concaviusculus, notabiliter acuminatis; theca oblongo-ovata; operculo obtusiusculo.*
2. V. hyperborea, *caule elongato subsimplici, foliis late ovatis vix acuminatis, valde concavis; theca ovato-globosa; operculo acuto.*

1. *Voitia nivalis.* Stems elongated, branched; leaves ovato-lanceolate, slightly concave, much acuminated; theca oblongo-ovate; summit of the operculum rather obtuse.
2. *V. hyperborea.* Stems elongated, nearly simple; leaves broadly ovate, sub-acuminate, very concave; theca ovato-globose; summit of the operculum acute.

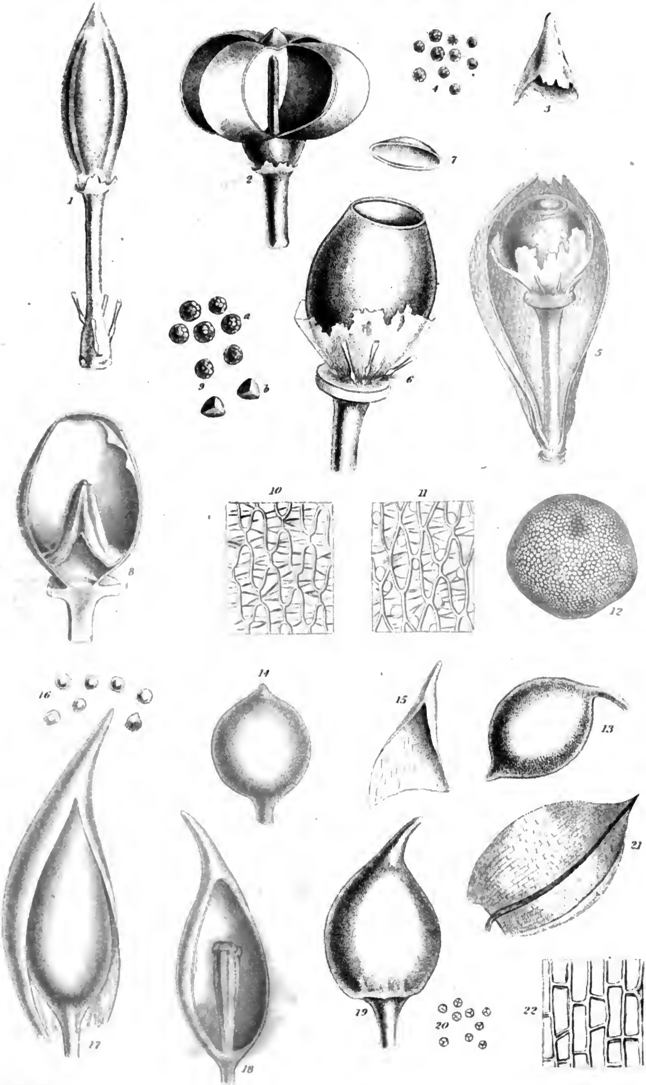
Plate VII.

Fig. 17. Theca of *Voitia nivalis*, with its calyptra.
18. Theca of the same cut open, to show the columella, on the summit of which are traces of the membrane which closes the stoma.
19. Theca of *V. hyperborea* (nobis).
20. Sporules; which are the same in both species.
21. Leaf of *V. hyperborea.*
22. A portion of the leaf of either species, showing the form of the areolæ.

All the figures more or less magnified.

PLATE VII.

ANDREA SPHAGNUM PHASCUM VOITIA.



R. K. Greville del.

W. H. Lizars sculp.

X.—*Short Account of the Rocks in the Neighbourhood of St John's, Newfoundland.*

By Mr John Baird.

(*Read 23d February* 1822.)

In approaching the fishing grounds on the coast of America, the soundings were from sixty to thirty fathoms; over the great Bank of Newfoundland, generally about thirty-five. The lead brought up a fine sand, and frequently small pieces of a rough flint, together with particles of a green smooth mineral, in the form of coarse green sand. It is certainly a singular fact, that so large a portion of shallow water should exist so far out at sea, the sea deepening so rapidly beyond the Bank. Is it not probable that a large tract of dry land had formerly existed where the Bank is now found? The rocks which formed this land may have been composed of very soft materials, and the occurrence of flint and green sand over the Bank seems to indicate that the greater part of the original rocks had been of the Chalk and Green Sand Formations. A country composed of these rocks, which are of the latest formation, must have been very low, and in consequence much exposed to the action of the sea. By degrees the whole may have been inundated and entirely swept away, leaving the harder debris, the flint and green sand, to form the gravel at the bottom.

The coast round St John's is bleak, bare, and rocky, and almost everywhere precipitous. On both sides of St John's harbour, perpendicular cliffs of trap-tuff rise to the height of three or four hundred feet. The interior of the country is hilly, but does not rise to a great elevation, few of the hills being more than five or six hundred feet above the level of the sea. They are generally round-backed, and frequently wooded to the top. The whole uninhabited part of the country is one immense forest, consisting chiefly of fir and birch. No extensive valleys or plains occur, but hill succeeds hill in almost unvarying succession. The physiognomy of the country is an elegant outline of hill and dale: the scenery, however, wants variety. Lakes are numerous over the whole island, as far as it is known, and many of them, near the coast, are large and beautiful. They occur even on the tops of the hills, and are said to be often of great depth. The soil is in general light. Oats and barley thrive; and potatoes, turnips, and other kitchen vegetables, grow fully as well as in England. Summer weather, in Newfoundland, is short, but warm, and very favourable to vegetation. The winter is uncommonly severe, the spring and autumn very changeable. There is good pasture for cattle in ground that is cleared.

The passage into St John's harbour, which in shape very much resembles a man's foot, is by a narrow entrance, called The Narrows, which extends nearly east and west about half a mile. Both sides of this entrance are high, abrupt, and rocky. The rocks are the same on each side, being continued across from the one to the other. I think there is little doubt that the opposite sides of the Narrows had once been joined. A rapid river runs into the harbour. The harbour itself, previous to the formation of the Narrows, may have been a lake. The river appears to have been once much larger. By the action of the sea withont, and of the river and lake within, the rent or chasm by which the river formerly emptied itself into the sea, may have been gradually enlarged, till it has attained its present size. The average width may be two or three hundred yards. Quidi Vidi (pronounced *Kitty-vitty*) River and Lake may one day present an entrance and harbour similar to those of St John's.

The mineralogy of the country round St John's is very simple. The first rock, on entering the Narrows, is trap-tuff. This rock is distinctly stratified, each stratum generally measuring two or three feet in thickness. The strata lie NE. and SW., or rather NE. by N. and SW. by S. The dip is to the NW., at an angle of from 70° to 80°. The basis of this rock consists chiefly of distinct grains of quartz, felspar, and a red claystone. The imbedded minerals or pebbles are, for the most part, of the same substances; felspar, common and compact, the latter with small imbedded grains of quartz; quartz, often of a slaty or fibrous structure; jasper, red claystone, bloodstone, hornstone, &c. These imbedded minerals, at the foot of the hill or cliff (particularly the quartz and felspar), are generally from an inch to three inches in diameter, and gradually decrease as we ascend; at the top of the hill, they rarely exceed the fourth part of an inch in diameter. Does not this fact countenance the mechanical deposition of the trap-tuff? This rock appears much harder than the common varieties of the trap-tuff which I have seen.

It is this rock which forms those precipitous cliffs on either side of *the mouth* of the Narrows. The opposite sides of the Narrows rise very rapidly from the sea to a considerable height. The highest part of the trap-tuff formation is about 300 feet above the sea; its thickness about 500 yards. The trap-tuff passes very gradually, and most beautifully, into the next rock, which is amygdaloid. In this passage of the one rock into the other, the stratified structure is still retained, one stripe or narrow stratum being distinctly marked trap-tuff, the next amygdaloid; the stripes of the former being broadest at first, gradually becoming narrower and less defined, till the amygdaloidal rock entirely prevails.

The strata of the amygdaloid also run in the direction of NE. by N. and SW. by S., and dip likewise to the NW. at an angle of about 65°. The basis of this rock, like that of the trap-tuff, consists of minute grains of quartz, felspar, and claystone. The imbedded portions are invariably of a red, smooth, hard claystone: they seldom have the amygdaloidal form, but are square or rhomboidal, or in longish slates. The greater part of the amygdaloidal rock is entirely destitute of these portions, while, on the other hand, more than one half of some of the strata is composed of them. The amygdaloid is frequently distinctly stratified, each stratum being a few feet thick.

The trap-tuff and amygdaloid are both of a reddish colour; the latter, however, sometimes occurs of a grey colour. The greatest height of the amygdaloid formation is 500 feet [*]; its thickness is about three or four hundred yards, extending from the top of Signal Hill to the foot of the Crow's Nest.

Resting upon the amygdaloid is found the greenstone, lower in height than the amygdaloid, but higher than the trap-tuff. This rock extends from the foot of the Crow's Nest (it being of greenstone) to the foot of the Signal Hill, or to the town of St John's, a thickness of six or seven hundred yards. The Crow's Nest, on which is built a small fort, is four hundred feet above the level of the sea. The principal constituent part of this rock is apparently felspar. Its most common colour is green, though sometimes grey and red; it is stratified, and sometimes possesses a beautiful slaty structure. The strata of the greenstone also run NE. and SW.; their dip is to the NW., at a much smaller angle than the preceding rock, the inclination not exceeding 50°.

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[*] This is the height of Signal Hill, the highest part of the formation.

Resting upon the greenstone we find the next rock claystone, the strata of which have the same direction and dip as the others, the angle of inclination, however, not being above 35° or 40°. The claystone formation extends two miles in thickness beyond the greenstone, occasionally alternating with strata of compact felspar, each stratum measuring from half a foot to a foot in thickness. The claystone being much softer than the rocks before described, the country where it prevails is also much lower. The town of St John's is built upon the claystone. In colour, it is most frequently grey, often also brown, dark-brown, red, whitish, and of other colours. It is often beautifully striped. It is fine-grained, smooth, and often conchoidal in the fracture. The strata of this rock are occasionally columnar, which is also sometimes the case with the greenstone; and the columns are composed of round concentric balls.

The next rock, whose direction, dip, and inclination are the same as those of the claystone, is compact felspar. This rock first alternates with the claystone, and then prevails alone for above a mile. Being harder than the claystone, the country composed of it is higher. Its colour is also various, light and dark grey, greenish-grey, green, blue, &c. It is translucent, or slightly translucent, on the edges, while the claystone is perfectly opaque. The compact felspar has a splintery conchoidal fracture; the fracture of the claystone, on the other hand, is even, and always smooth. The compact felspar is more or less fine in the grain, and the splinters more or less large. The strata of the compact felspar, like those of the greenstone and claystone, are also at times columnar, the columns being composed of small round concentric balls, and very brittle. These balls are at times partially composed of hornstone. This mineral occurs also in the compact felspar, in thin beds, in veins, and in masses: its colour is green, its fracture smooth, conchoidal, it is slightly translucent on the edges, and is as hard as quartz.

Claystone again succeeds the compact felspar, and the latter is again succeeded by the former, thus alternating for about eight or ten miles across the peninsula. The claystone always possesses a slaty structure, and soon decays. The soil over the greenstone and amygdaloid is rich and good, while over the claystone and compact felspar it is light and poor.

XI.—*Observations on the Snowy Owl,* (Strix Nyctea, *Linn.*)

By Laurence Edmondston, Esq.

(*Read 23d March* 1822.)

The Snowy Owl was long known to be a native of the northern countries of Europe, but it has only more recently been ascertained to be a British bird.

I fell in with this species in Zetland, first in 1811; and, the following spring, I shot an adult male, which I shortly after presented to the proprietor of the Piccadilly Museum, Mr Bullock, at the same time communicating to him some facts regarding its habits which had come under my observation. That gentleman soon after published an account of this species in the Transactions of the Linnean Society of London; and since that period, it has, of course, been considered as a British bird.

Its Zetland name is *Catyogle*, which is indeed the general appellation given indiscriminately to all owls in that country, and it occurs chiefly in the Island of Unst, the most northerly of the group; but even there it is extremely rare, and very local, attaching itself only to two or three districts of the island. The specimen now exhibited to the Society, which I have lately procured from that quarter of the country, was killed in December last. It is a female: the ovaria were very large, and well marked. It was altogether an uncommonly muscular and robust bird.

The external appearance of this species has been well described by ornithological writers: for this, I shall therefore refer to them; and shall only observe, that the plumage of this particular individual is singularly rich and beautiful. The dusky spots are more numerous than usual, which I am disposed to attribute rather to the circumstance of this bird not being arrived at permanent plumage, than to peculiarity of sex. The extent between the wings was five feet five inches; and the bird weighed five pounds, which is much beyond what has been commonly stated to be the weight of this species; but I suspect that, in the large owl, as in the eagle tribe, the females are larger than the males. Though, as has been alleged by ornithologists, it may be more active and alert during the day than other congenerous species, especially when it is once alarmed, yet I have never remarked it seeking for its prey but towards evening.

It rests generally beneath some stony projection, which protects it from the direct influence of the sun; and some instances have occurred of its being surprised asleep during the day, and forfeiting its life to its supineness.

Its form and manner are highly elegant; its flight less buoyant, and more rapid, than that of the other owls; and the superior boldness and activity of its disposition, the uncommon size of its talons, and vigour of its limbs, secure it against danger from feathered enemies.

It affects solitary, stony, and elevated districts, which, by the similarity to it in colour of the rocks, render it difficult to be discovered, and by the inequalities of their surface afford it shelter from the rays of the sun; but on the approach of twilight, it may be seen perching on the exposed eminences. It then quits its haunts, and frequents the cultivated fields, prowling over the low grounds in quest of mice and small birds. When first observed to leave its retreat, it is frequently assailed by crows and other birds; but it receives their attacks rather as an amusement than an annoyance, and dashes through the air despising their hostility.

It preys chiefly on sandpipers, on which it pounces with precision and agility as it skims along the marshes. The specimen given to Mr Bullock's Museum, had an entire one in its stomach when I shot it; and a mouse perfectly whole was taken from that of the present specimen.

I may here remark, that the stomach appears to be peculiarly small, and less membranous than what occurs in other carnivorous birds, and the food seems to be swallowed entire;—indeed, its bill being feathered to its point, renders this almost necessary.

When wounded or irritated, it hoots very vehemently, shaking its feathers, and striking rapidly with its feet; but otherwise, it appears to be as silent as it is recluse. And those screams, which Pennant describes as adding horror even to the desolate polar wastes, though a fine feature of wild sublimity, yet seem wanting to the scenery of Zetland,—this robust arctic warbler perhaps reserving his melodious powers for the icy solitudes of his favourite regions.

From the secluded nature of its retreats, its great rarity, and the superstitious aversion in which it is held by the islanders, who regard it a bird of ill omen, it is not surprising that its breeding-place in Zetland is so obscure. I have never heard of its nest having been found either there or in Orkney,—though, from meeting with it at all seasons, and from its constantly, during the summer, frequenting the same situations, in perfect plumage and well developed sex, it is reasonable perhaps to conclude that it breeds in Zetland. Indeed I remember an intelligent peasant of Unst, whose veracity and accurate acquaintance with his native birds I had occasion to be satisfied with, assuring me of his once having met, in the month of August, with a pair of this species, having along with them two others, which he termed their young. One of these latter he shot; but unfortunately I was not aware of the circumstance till the specimen was destroyed. He described it as of the same size as the Snowy Owl; indeed, in every respect the same, but of much darker plumage; and this is all precisely what we should expect, on the supposition of this species breeding in Zetland.

A new and elegant species is thus added to the list of British birds; and a future opportunity may enable me to communicate some details, of which the peculiar facilities for ornithological pursuit of the Zetland Islands have put me in possession, illustrating the habits, and defining more accurately other genera and species of a class of animals so interesting to the naturalist, so generally diffused, yet still too often so obscurely known.

Edinburgh,
9th February 1822.

XII.—*Meteorological and Hydrographical Notes.*

By Capt. R. Wauchope, R. N.

In a Letter to Professor Jameson.

(*Read* 15*th December* 1821.)

Although the temperature of the waters of the ocean is a highly curious and important subject, it is not, I believe, many years since it claimed the attention of navigators. I have frequently experienced the utility of noting its changes, and have no doubt the same has been felt by many others. As you are collecting observations on this subject, and expressed a wish to know the results of some of my observations, I now send you the following Table, *viz.* of those made on the surface-water of the sea between St Helena and England.

The observations were made at three different periods of the day, *viz.* at 8 A. M. noon, and 8 P. M.

1. TABLE, *shewing the Relative Temperature of the Surface-water of the Ocean and the Atmosphere, between the Island of St Helena and England.*

LAT.	LONG. W.	8 A. M.		Noon.		8 P. M.		October 1819.	Set of the Current on each day.
		A.	W.	A.	W.	A.	W.		
15° 6′ 0″ S.	6° 30′	-	-	-	-	65½	67½	4	N. 52 W. 7 miles.
13 35 0	8 5	68	67	74½	67½	67½	67½	5	Do.
12 43 0	9 24	70¾	69	71	69½	68	70	6	N. 71, W. 9½.
11 46 0	10 35	71¼	70½	77½	71½	71	72	7	N. 85, W. 16.
11 21 0	10 52	74	72	81½	75½	71	72	8	N. by W. 6.*
10 2 0	12 0	72¾	72½	73	73¾	72½	73	9	N. 10.
8 46 0	13 49	74	73	74	74	73½	74	10	S. 25, W. 13.
Anchor at Ascension.		74½	73½	-	-	-	-	11	On shore to-day. Ther. 81° in the shade at noon.
6 45 0	15 37	74	74½	74¾	75	74	76	12	S. 51, W. 6½.
5 28 0	16 41	75	75	78	76	74	76	13	S. 21, E. 14.
4 3 0	17 48	77½	76	79½	77	75½	77	14	S. 11, E. 5.
1 59 0	18 27	78½	77	78	77½	77	77	15	West 10′.
0 0 32 N.	18 49	77½	76½	79	76¾	77	77½	16	S. 52, E. 9.
1 44 0	18 40	78	78	78½	78½	76	78½	17	S. 22, E. 5.
2 47 0	18 42	74½	78½	77	78¾	75	79	18	S. 12, E. 17.
3 36 0	18 21	78½	79½	80½	80½	77½	79½	19	S. 12, E. 17.
4 39 0	18 39	77½	80	82	81	77½	81	20	East 12.
5 0 0	18 37	78½	80	78	80½	75	80	21	N. 56, E. 10.
5 37 0	18 44	79¼	80	80	81½	78	80½	22	East 10.
5 58 0	18 40	80	80	82	82	78	80½	23	N. 72, E. 13.
6 43 0	19 2	80	80	82	81¾	78	81	24	East 6.
7 8 0	19 13	80	81	82	81¾	78	81½	25	N. 56, E. 6.
7 28 0	19 4	80	80¾	83	83½	79	81	26	East 9.
8 21 0	20 0	79	80¾	80¾	81	79	80¼	27	S. 68, E. 19.
10 24 0	21 49	80	80	80¼	80	72	79¼	28	N. 86, W. 12′.
12 3 0	23 52	78	78½	78	78½	77	78	29	N. 60, W. 8.
13 19 0	25 53	77¾	77¾	78	78	76	76¼	30	S. 72, E. 9.
14 41 0	27 22	76½	77	77¾	76	76¾	77	31	N. 69, W. 8.
16 31 0	28 42	76	76½	76	76½	74½	76	Nov. 1	S. 84, W. 9.
17 59 0	30 30	74¾	76	75½	76	73	75½	2	S. 52, W. 10.
20 2 0	32 15	73½	75	74	75¼	72¾	75	3	No current.
22 19 0	33 15	73	74½	73¾	75¼	72½	75	4	S. 84, W. 9.
24 0 0	34 0	74	74	74	74¾	72	75	5	No current.
25 14 0	33 44	74¾	74	76½	74¾	73	73¾	6	No current.
26 7 0	32 59	71¾	74	68½	73½	69½	73½	7	No current.
27 5 0	32 6	67¾	73½	69¼	73¼	68½	73½	8	East 9.
27 52 0	33 56	67¾	72¾	68½	73	65	72½	9	No current.
28 4 0	34 4	66½	72¾	73	73	69	68¼	10	S. 72, W. 11.
28 18 0	33 49	69	72	72½	72½	70	71½	11	S. 16, W. 7.

* Current tried in a boat.

Table continued.

Lat.	Long. W.	8 A. M.		Noon.		8 P. M.		Nov. 1819.	Set of the Current on each day.
		A.	W.	A.	W.	A.	W.		
30° 7′ 0″ N.	33 8	71½	69½	71½	71¼	69½	69½	12	S. 59, W. 8.
33 34 0	32 8	69	69	70¾	70	66	65½	13	West 20′.
36 52 0	31 9	65	63½	67½	65	62½	62¼	14	West 11′.
— — -	- -	62	63	63	62	61	61¼	15	West 4.
41 42 0	27 86	60	61	63	60½	60	60	16	None.
42 46 0	24 37	59½	60	61	60	58½	60½	17	N. 45, W. 3½.
43 48 0	21 26	57	58	56½	57	56	57	18	Do. do.
44 55 0	18 20	55½	56¾	57½	56	55½	57	19	Do. do.
45 29 0	15 42	53¾	55½	54	54¾	55	55¼	20	No observation.
46 42 0	10 26	51½	54½	-	-	51	54½	21	
48 12 0	7 35	52¾	52½	51½	51½	48	52½	22	
49 28 0.	5 16	44½	51½	43½	51¾	-	-	23 24	Midnight. Eddistone light in sight.

In the foregoing table, the Thermometer merely marks the temperature of the atmosphere, and of the water at the surface.

I shall state some of the advantages which may be derived from keeping an account of this kind.

1. It may be the means of determining the various situations of banks or shoals in the ocean; for where the bank approaches the surface within 140 fathoms, the temperature upon it will be found to fall very considerably below that of the surrounding water.

Upon the 18th January 1819, upon approaching the Continent of South America, at 8 A. M., I found the temperature of the water to be 74¾ degrees; and as the thermometer stood the night before at 80°, I immediately hove to, and sounded, and got bottom in 100 fathoms, Lat. 22° 31′ S., Long. 40° 31′ W. The thermometer in this instance had altered 5¼ degrees.

Again, on the 9th April 1819, on approaching the Cape of Good Hope, from St Helena, at noon, the thermometer stood at 65° at the surface of the water; at half-past 2

P. M. the same; at half-past 3 it stood at 62°. I hove to, and got bottom in 145 fathoms; Cape Point SE., Lion's Head NE. Here the difference was only 3°, and the water was 45 fathoms deeper than in the former experiment.

On coming into soundings in the English Channel, I found 5° difference of temperature.

If there are banks in the ocean which approach as near to the surface as 140 fathoms, they will be indicated by the fall of the thermometer in the surface-water; and all navigators will immediately perceive the advantage of determining their latitudes and longitudes by means of such banks, as from them ships may frequently be enabled to ascertain their situations with as much certainty as from land.

2. *Temperature of the Ocean at great depths.*

The following experiment was made to determine the temperature of the ocean at a considerable depth. The thermometer was inclosed in the middle of six cases, all of tin, except the outer one, which was of wood; each case had a valve below and at top, both opening upwards, in this manner; the valves remaining open when descending, but closing when coming up. The four inside cases were separated from each other about a quarter of an inch all round, allowing the water to pass freely between them. The fifth case was distant from the one immediately inside of it about half an inch, and the space between filled up with *tallow*. The outer case of all, or sixth case, was of wood,

of an inch thick, and separated about an inch from the fifth case by a column of water. The size of the machine altogether was about two feet high, and ten inches in diameter. To the bottom of the machine was fastened a weight of 72 pounds, and to the upper part the end of a coil of two-inch rope. I first veered 779 fathoms of two-inch rope overboard, then 390 fathoms of two and a half, then 266 fathoms of three-inch, making in all 1435 fathoms of rope.

I had attached a thirty-two-pound shot to every 200 fathoms. It took twenty-two minutes to veer the whole overboard; and the apparatus was allowed to remain, after the whole was veered out, twelve minutes, before we commenced hauling it in, that the whole might have time to sink. From the great friction, we found much difficulty in getting it on board again; it took a hundred men just one hour and twenty minutes to do so. The thermometer, when it came up, stood at 42°, and the temperature of the surface-water was 73°, making a difference of 31°. I should imagine that the thermometer here had sunk about 1000 fathoms: the line did not go down perpendicularly. I determined the perpendicular depth by taking the angle which the line made with the ship's bow, and calling the line veered out the hypothenuse of a right-angled triangle, (which would not be quite correct). I thus found the perpendicular depth to be 1100 fathoms: but as the line would form a curve, I think the perpendicular depth would be as near as possible about 1000 fathoms. A little breeze sprung up towards the end of our operations, and the ship rode to the sunk line precisely as if she had been at anchor.—This experiment was made on the coast of Africa, in Lat. 3° 26′ S., Long. 7° 59′ E.

3. *Effects of the Weather on the Barometer, at the Cape of Good Hope.*

The next remarks I mean to trouble you with, are some observations upon the weather, with the effects which this has upon the Barometer, at the Cape of Good Hope. The barometer, from being more observed and better understood, has, of late years, added much to the safety of navigation. I can state for myself, that when I have got acquainted with the range of the barometer in any country, it never has deceived me in its predictions. The utility, then, of ascertaining the range, and the way in which the different winds affect the barometer in different climates, becomes a matter of very high importance to the navigator. From remarks of this description, in a very short time a set of observations might be compiled for every port of the world, to accompany the barometer: and such remarks would, in many cases, prove of consequence to the safety of a ship.

The summer months, at the Cape, are counted from the middle of September to the middle of April. The prevailing winds during this time are from the south-east: this is always a dry wind here; but a degree or two, at sea, to the westward of this, I never saw this wind unaccompanied with rain and damp weather. I did not observe the range of the barometer during the months of December, January, and February, to exceed .29 parts of an inch, ranging from 30.14 to 29.85. During summer, when the barometer rises above 30 inches, with a SE. wind, it will always blow strong: when above 30 inches, with a westerly wind, it will be fine moderate weather. The rainy winds, at all seasons, are, the NE., NW., and SW.: this last is often a dry wind.

I insert two examples of the Barometer during summer; the first shews the state of the barometer during a SE. gale, and the next its state during the NE. and westerly winds.

I.

December 1817.	Time of day.	Wind.	Barom.	Therm.	State of the Weather during the SE. Wind.
5	8 P. M.	SE.	30,06	64	Strong breezes.
6	8 A. M.	SE.	30,10	67	Strong gale.
	Noon.	SE.	30,13	67	Very strong gale.
	8 P. M.	SE. SSE.	30,13	66	Very strong gale.
7	8 A. M.	SE.	30,14	71	Very heavy gale.
	Noon.	SSE. var.	30,12	67	Light airs, and fine.
8	Noon.	Do. do.	29,90	74	Moderate and fine weather.

II.

December 1817.	Time of day.	Barom.	Therm.	Wind.	State of the Weather during Northerly & Westerly Winds.
11	8 P. M.	29,97	69½	NNE.	Strong breezes, and squally, a little rain.
12	8 A. M.	29,95	63	NNW.	Moderate and cloudy.
	Noon.	29,93	63½	NNW.	Moderate and cloudy, with much and heavy rain.
	8 P. M.	29,93	64½	NW.	Heavy rain.
13	Noon.	30,04	62	WSW.	Moderate and fine weather.
14	Noon.	30,01	62	SW.	Light breezes, and fine.

The range of the barometer during the winter months, viz. from the middle of April to the middle of September, is much greater than during summer. The greatest range I have observed being .85 parts of an inch, from 30.30 to to 29.45. This last is by far the greatest depression I have observed, and this but once. I had never before seen it lower than 29.65, and then it blew very hard from NW. It may be laid down as a general rule in this climate, that whenever the barometer falls as low as 29.70, during the winter months, it will blow hard from NW. or NE.; when as low as 29.65, it will blow very hard; and when below this, a heavy gale. The NE. wind is an uncommon wind at the Cape. I have seen moderate and light breezes from the NE. for twenty-four hours, but this is rare. A NW. or SW. gale sometimes commences with the wind NE., and it may blow very hard, with squals, for an hour or two, from this quarter; I think rarely longer than two hours. A ship ought to be prepared when this occurs, as the wind will most certainly fly round to the SW. or NW. at once. And whatever tack the ship might have been on before, she ought now to get upon the starboard tack; for after it has blown hard from the SW., and a heavy sea has got up (this wind raises the heaviest sea), it frequently flies round to the NW. suddenly; and it is those sudden shifts of wind which make the sea off the Cape of Good Hope so dangerous.

The following example shews the state of the Barometer during a heavy gale in winter. The quicksilver here fell as low as 29.45, which was lower by .20 of an inch than I had ever observed it before.

1819.	Time of day.	Wind.	Barom.	Therm.	State of the Weather.
May 31.	8 P. M.	SSE.	30,10	60	Light airs, and fine weather.
June 1	8 A. M.	NE. by N.	29,93	58	Mod. not blowing very strong.
	Noon.	NE. by N.	29,83	59½	Moderate weather.
	8 P. M.	N. by E.	29,66	62½	At 1½ A. M. very heavy squalls from NE. Blowing strong and squally.
June 2.	2½ A. M.	SW.	29,50	—	It had been blowing hard from NE. when we were taken aback from SW. a heavy gale.
	4 A. M.	WSW.	29,45	—	Blowing very hard; a heavy sea getting up.
	8 A. M.	WSW.	29,56	59½	Now that the quicksilver has begun to rise, the squalls are heavier than ever, with rain, but do not last so long.
	10 A. M.	W. by S.	29,70		
	Noon.	W.	29,71	59¼	Still blowing strong,
	1¼ P. M.	Do.	29,79	—	And squally, but more mod.
	2 P. M.	Do.	29,81	—	Sun out; at times much more moderate. Heavy sea.
	4 P. M.	Do.	29,90	—	Moderate, with much sea.
	6 P. M.	Do.	30,00	60	Moderate and clear; light winds at times.

Remarks.—At sunset, on the 1st of June, the wind was so moderate, and the weather looked so fine, that I was almost tempted to believe we should not have any very bad weather; however, the mercury still continuing to fall, induced me to close-reef the topsails, and get top-gallant yards on deck. At 8 P. M. there was no appearance of a gale, but the mercury still falling, I got top-gallant masts on deck, and all the storm-sails bent, and every thing prepared for a gale. About 1 A. M. the gale commenced, blowing very hard in squalls from the NE. We were on the starboard-tack, and quite prepared for being taken a-back with the wind from the SW., which happened accordingly at half-past 2. The wind came after this very steadily from the W. by S. and W., blowing exceedingly hard, with very heavy squalls. We found it here, and I have in general observed it to be the case, that, just at the time when the mercury begins to rise, the squalls increase in violence, but do not last so long. From noon of the 2d, till 4 P. M., I think the sea was heaviest, very irregular, and breaking exceedingly: some of the seas broke so much as to have the appearance of high breakers. It went down, however, very fast, and at 8 P. M. there was not much sea. Had we been to southward and eastward of the Cape, we should have had a much heavier sea, in consequence of the currents being stronger there. The strength of the currents here is very extraordinary, and it will appear the more so, when it is mentioned that they are strongest during a NW. gale, which blows exactly in the opposite direction to them. On the 7th January 1818, I was set to the westward against a strong NW. gale 70 miles during the first 24 hours, and 63 miles during the next. With a SE. wind, I never observed the current very strong off the Cape.

The predominating colour of the clouds during those westerly gales is a very light soot colour, in large rounded masses, over a pale brass-coloured ground; as the gale breaks, the clouds assume a darker colour. The sky invariably assumes this pale brass-colour before the gale comes on. An old pilot, who had been upon this coast for thirty years, first mentioned this to me: he said, whenever he saw the sky have that brassy-like appearance, and those *double-headed clouds*, he was sure that a westerly gale was coming on. What he meant by his double-headed clouds, were those rounded masses I mentioned above: they are of different shades; the light-coloured are highest, and they shew out from under the darker ones, giving just that appearance which is best expressed by *double-headed.*

I have been thus particular about the weather here, to shew the very great advantage which may be derived from the study of the barometer; for had I not been prepared before the gale came on, I most certainly should have lost my masts, and most likely the ship and our lives; for on our arrival at St Helena, we found our foremast so rotten, that it was a wonder, after all our precaution, how it stood during the gale.

4. *On Under-Currents.*

I have only a very few remarks to make respecting the under-currents. That there are under-currents in the ocean, I ascertained in the following manner. After having moored the boat in the usual manner, I lowered a very large white flag down a few fathoms below the surface, and was surprised to see it carried out by a current in an opposite direction to the current which was running on the surface. In Lat. 32° 38′ S. Long. 13° 45′ W. the current on the surface set E. by S. 7 miles; at 10 fathoms, the flag was carried out NE. by N.; at 15 fathoms, the same. I tried this experiment again the same day, and found the surface-current to set E. by S. 7 miles; at 10 fathoms, E. ½ N.: at 13 fathoms, NE. ¼ E.; at 15 fathoms, the same. Again, in Lat. 30° 33′ S. Long. 13° 40′ W. current on surface E. by S. 14 miles; at 10 fathoms, NE. by E.

5. *Range of the Barometer at St Helena.*

At St Helena, during the many months which I had an opportunity of observing the barometer there, I never have found it range more than .45 parts of an inch: the two extremes are 30.25 and 29.80. The usual height is from 30 to 30.10. The wind here varies very much with respect to its strength, but seldom above a few points in its direction. It seems to be affected a good deal by the moon; for I have always observed, and had my observations confirmed by all the ships on the station, that, at or near full moon, there are light winds; and at the first and last quarter it blows strongest. At all times, it blows stronger about noon than at any other time of the day.

6. *On the Phosphorescence of the Sea.*

I shall only mention one observation, which induces me to believe, that, in some cases at least, the shining appearance observed frequently during the night in the ocean, is occasioned by phosphorescent animalcula. In September 1816, in Lat. 4° 52′ S. Long. 9° 19′ E., I observed this shining appearance very strongly, which induced me to draw a bucket of water, for the purpose of examining it. I had it suspended so as to have as little motion as possible; when this was the case, it shone very little; but the moment it was disturbed, it shone with great beauty. I next got a little lime-juice, and put a wine-glass full of this acid into the bucket, when the shining particles began to move about in all directions, sometimes going only as far as the middle of the bucket, then turning and taking a zig-zag direction. These motions certainly had every appearance of the depending upon the will of an animal: they shone with much splendour, and some appeared as large as the tip of one's finger. Another glass of lime-juice instantly destroyed them; for, at the instant the second quantity was poured in, the water appeared to be one blaze of fire, and no motion or disturbance could make it shine after this.

I then drew some more water up, which shone as before; part of this I kept during the night in an open vessel, and part tightly corked up in a bottle; and the next night, on examining these two portions, I found that the water in the open vessel shone pretty brightly, but not so bright as it did; and that which had been corked up did not shine in the least, the want of air seeming to have killed the animals. They appear to me to be coated with some phosphorescent matter; for one of them I happened to rub upon my fore-finger, which left a streak of light for a few seconds, as long as the first joint of my finger. Now, when the fire-fly, or the glow-worm, are killed, their light is immediately extinguished.

XIII.—*Account of the Small District of Primitive Rocks, near Stromness, in the Orkney Islands.*

By Mr GEORGE ANDERSON of Inverness.

In a Letter to Professor JAMESON.

(*Read* 17*th November* 1821.)

DEAR SIR,

THE point on which I have taken the liberty of addressing you at present is not of any great importance, but I think you will still consider it worthy of notice. It refers to the extent of the Primitive District in the Orkneys.

From the notes I had taken from your Lectures, and, if I recollect well, from your Mineralogical Travels, I was led to expect that this district was only one or two miles in length, by half as much in breadth. While examining it, however, along with my friend Mr CHARLES CLOUSTON, with whom I spent some weeks this last summer, I found that the longitudinal direction of the primitive strata lies from SE. to NW., commencing with the harbour of Stromness, and running through the high hill above that town to a place called Yeskanaby, on the west coast of Pomona, two miles on this side of the house of Skail. Here it terminates in a high mural precipice overhanging the sea, and, to the north, is immediately succeeded by the common greywacke-slate, and by a greyish sandstone, which, from its hardness and crystalline texture, is the only stone of that kind used for mill-stones in the whole island. Perhaps its vicinity to the strata of primitive gneiss may have given it these superior qualities.

From this point of Yeskanaby we traced the gneiss (which is of the common grey kind, traversed by numerous veins of felspar and quartz) in a continuous and uninterrupted line back all the way to Stromness, and thus found its greatest length to be from six to eight miles.

Its utmost breadth lies between the Island of Græmsay, which is partly formed of gneiss, and the Bridge of Wae, where the road crosses Loch Stennis, in the direction of Kirkwall. I also thought that this breadth might be still greater, from an expectation that gneiss formed the fundamental rock of Hoy, founded on a report that gneiss or granite had been seen near Rackwick, on the south-western side of this latter island. Of this, however, we could observe no confirmation, but noticed at the same spot a large bed of greenstone among the strata of red sandstone. The lateral extent of the gneiss, therefore, does not exceed two or three, or at the utmost four, miles; and even this, as we approach its northern extremity, near Skail, gradually tapers to 100 or 200 yards.

From having thus traced the boundaries of the primitive district in the Orkneys, we may presume that no strata of that class will be found in the Island of Pomona, or Mainland of Orkney, to the north of Yeskanaby or Skail; for we saw the gneiss evidently running out at this point under the waves of the Atlantic Ocean. From the same circumstance, we may also remark, that here, as in other parts of this kingdom, the primitive and highest lands are on the west; and further, that the gneiss in Pomona appears in the form of a nucleus, round which, or towards which, the secondary strata uniformly tend.

I am, &c.

Inverness,
27*th October* 1821.

XIV.—*Account of a New Species of Larus, shot in Zetland.*

By LAURENCE EDMONDSTON, Esq.

(*Read 24th March* 1821.)

IN no department of Ornithology have obscurity and error been more conspicuous than in what relates to the Gull tribe. Although widely diffused—of roaming and migratory habits—of striking and interesting peculiarities of instinct—and comparative familiarity of disposition, many of the species of this genus of birds have been long indistinctly characterised; and some are yet hardly known to naturalists.

The young, of all the species of gull of which we have any accurate account, differ from the parent-birds in their plumage, and frequently in their modes of life; and the different species approach each other often by such nice gradations, that, without a continued and intimate acquaintance with their varied appearances in their native regions, or the possession of that practical tact in detecting specific differences, which such an acquaintance is best calculated to confer, a mere examination of the external characters and anatomical structure of any particular individual, or a transient observation of its habits, will often be found inadequate to determine its specific rank. For example, the Lesser was long confounded with the Greater Black-backed Gull, and the young of the *Parasiticus* described and figured as a distinct species.

The rare and very interesting species of gull which forms the subject of this paper, seems, till lately, to have eluded the observation of ornithologists, and, inhabiting and visiting only remote regions, to have been known only to their rude inhabitants. But although I have myself observed it on the shores of the Baltic, and on the coasts of the German Ocean, it is to its occurrence in the Shetland Islands that my present observations are exclusively confined. In that country, possessed of so many rare facilities for the investigation of its zoological objects, I first became aware of the existence of this species, by accidentally shooting an individual of it, in the autumn of the year 1809. The singularity of its appearance attracted my attention; and though then but a novice in ornithology, and diffident in indulging the hope of discovering a new species, in a tribe of birds so prominently exposed to the view of naturalists, yet my curiosity was awakened, and my exertions to procure accurate information of its history and habits became indefatigable. That specimen was, unfortunately, soon destroyed; but, in 1814, I procured another, which I immediately afterwards presented to Mr Bullock, for his Museum in Piccadilly, and it continued to be exhibited there till the dispersion of that valuable collection. Its description is the following. Length two feet nine inches, breadth five feet four inches, irides silver-grey, and the feet flesh-coloured. The general colour of the body ash, with a slight shade of brown; darkest on the back, where, on some of the feathers, a faint tinge of blue might be perceived; the head streaked a little with grey; the rump and vent irregularly barred with pale-brown, and the *primary* and secondary quills dull *white;* the bill nearly of the same length as that of the Greater Black-backed Gull, but more slender, and less hooked. The tail consisted of twelve feathers, of a bluish-grey colour, some of which were faintly and irregularly barred with dull white. In weight, this species is little inferior to the *Larus marinus*, and occasionally it occurs even of a greater size.

The specimen which I have now the honour of submitting to the examination of the Society, differs in no important respect from the individual above described. Its size is rather smaller; but this was obviously owing, chiefly to the unusual leanness of the bird when it was killed, and to the subsequent shrinking during its preservation. Its plumage, generally, is darker; the brown spots and bars occurring on the wing-coverts, and on some other parts of the body, better defined, and the irides dark-brown; but these varieties are at once accounted for, on the supposition of its being a younger bird. From this consideration, I have preferred giving here the description of the specimen sent to London, to that of the present one; and also from its affording a more accurate representation of the general appearance and size of this bird, as met with in the Zetland Islands.

This species is never known to breed in Zetland. It arrives in that country about the middle of autumn, and leaves it toward the end of spring; and this migration appears to be completely general, at least, I do not remember seeing one during the whole summer season. In this respect it totally differs from all those species of known Gull, to which, on a superficial view, it might be supposed to approximate.

Its favourite resorts are the entrances of the more exposed bays; or the ocean, a few miles off the land, where it is often found assiduously attending the fishing-boats, to pick up any offals that may be thrown overboard; and it is often taken by a line and hook baited with fish, when engaged in this pursuit.

It is greedy and voracious to a proverb; and when allured by carrion, which seems to be its favourite food, becomes comparatively indifferent to danger. It then quits the ocean and the headlands, enters the bays, and boldly ventures inland.

Generally speaking, it is rare; and I have hardly above once seen more than three or four individuals at one time. Occasionally a single bird may be met with, attending a large flock of its congeners, and feeding along with them. Upon these occasions its peculiarity of appearance is very striking.

Its usual deportment is grave and silent, exhibiting little of the characteristic vivacity or inquisitiveness of many of its tribe, and it is roused to exertion chiefly by a sense of danger, or the cravings of hunger.

When it flies, it extends its wings more than the other species of Gull, and its flight is also more buoyant. And when not in quest of food, it is of a reserved disposition, and seldom comes within the range of a fowling-piece, but soars at a respectful distance, uttering, at intervals, a hoarse scream, of a sound quite peculiar to itself.

It exhibits none of that remarkable instinct so predominant in many species of the genus, which prompts them frequently, at the hazard of their own lives, to warn other animals of the vicinity of the sportsman; but when once alarmed, it commonly flies off.

Independently of considering this bird as a new species, I had all along been induced to regard it as in an imperfect stage of plumage, having observed a considerable diversity of colour amongst several individuals which I had an opportunity of examining,—some being darker, and others lighter, than the specimen I have described,—and the colour of the iris presenting a corresponding variation, from dark-brown to silver-grey. These changes are perfectly analogous to what occurs in the young of the greater part of the genus, and hence I was led to the conclusion of the present specimen being a young bird. But as, in those species to which this resemblance applies, the iris attains its permanent colour some time before the perfect plumage is assumed, I could only form a vague conjecture of its adult appearance. Fortunately, however, in the same flock, from which I killed the specimen above described, was a considerable number of individuals of this species, in what I decidedly consider maturity of plumage. In general appearance and habits, no difference could be detected. The back and upper part of the wings were light-blue, passing into white. All the rest of the body, and the primary and secondary quills, dull-white.

In the month of November last year, I observed a flock of upwards of a hundred of this species in the Bay of Balta Sound, in Shetland. They remained there for two or three weeks, going out to sea, in search of food, regularly at a particular period of the tide, and returning to rest for some time in the Bay. During this time I had ample opportunities of observing their appearances and habits, and of completely confirming all the views I had previously entertained concerning them. Unfortunately I could not at that time procure an adult specimen, from the want of sufficiently heavy shot, the peculiarly thick-set plumage resisting, at any considerable distance, the effect of the smaller sizes, which could then alone be procured in that distant quarter of the country.

It is in Unst, the most northerly island of the group, that I have found it most frequently, and where it is chiefly known. It is there that I have observed it first to arrive; and this most generally occurred when the wind was favourable from the Arctic regions.

In stating the claims of this bird to specific distinction, the circumstance will not be overlooked, of its being regarded by the Shetland fishermen as a distinct species. Such an opinion is not to be considered as wholly unimportant; for, unbiassed, in this instance, by prejudice or selfishness,—possessing the most select opportunities of accurate observations on the more palpable and distinguishing peculiarities of those birds which their country supplies,—their attention, from their modes of life, naturally directed to those observations,—and they being acute, and perfectly competent to arrive at just conclusions in connection with them,—their testimony may be considered, at least, a strong presumption, in support of the pretensions of this bird to distinction of species. Indeed, I have seldom found their sagacity fail in accurately marking such specific boundaries; and, in this instance, in compliance with their conviction, they have distinguished this bird by the name of Iceland *Scorie*, (or the Young Iceland Gull); *Scorie* being the general Shetlandic appellation for the young of several species of the gull family.

Of the place of its breeding I know nothing. It is probable, I think, that it selects for this purpose the shores of Lapland and Norway, of the Faro Isles, and of Iceland. The name, indeed, given to it in Shetland, would seem to indicate that it is at least found in Iceland, although I have not been able to trace the origin of the appellation. The intercourse between that country and Shetland was formerly more frequent; and if it was observed to be numerous, or to breed there, it might naturally enough receive the name of Iceland Gull.

Additional Account of the Iceland Gull.

By Mr Laurence Edmondston.

(*Read 23d March* 1822.)

In February, last year, a paper was read to the Society, describing an interesting species of Gull, which I had first met with in the Zetland Islands in 1809, and which is known there by the name of Iceland Gull. A specimen was at the same time exhibited; and, though a young bird, and not arrived at mature plumage, it sufficiently displayed the more prominent external distinctions of its species.

I have since, however, been fortunate enough to procure an adult bird, which will more clearly confirm the opinion of its being a distinct species, and establish the accuracy of what I formerly suggested regarding it.

This specimen, which is now exhibited, and is submitted to the examination of the Society, weighed 5 pounds; its breadth, between the wings, was 5 feet 2 inches; the length, from the point of the bill to the tip of the tail, 2 feet 5 inches. The back and upper part of the wings pale-blue, head and neck streaked with grey. The upper part of the two middle tail-feathers ashy, but this appearance is quite accidental and unimportant; the rest of the plumage and the primary quills white; irides pale-yellow; the claws are dusky; the feet and legs much like those of the Herring Gull, but considerably larger; the wings, however, proportionally shorter; the general shape of the body fuller, and less tapering; the neck is unusually thick and strong; its flight is more equal and measured, and has less of that kite-like soaring which others of its tribe affect. The bill is long and powerful, not so much hooked as that of the *Larus marinus;* and when the bird is alive, it is of a pale-yellow colour, with a patch of a deeper shade near the point of the lower mandible; its length is four inches.

This specimen was a very distinct male, and was shot in Balta Sound, Zetland, in November last (1821), out of a flock of two or three hundred of this species.

In some specimens that I have examined, in Zetland, hardly any grey was to be seen on the head or neck, and such I consider as in the more perfect and permanent plumage.

When I first described this species in 1814, I was not aware that any thing similar to it had been noticed by ornithological writers, the remote situation of Zetland being so little favourable for my consulting books on natural history. I have since, however, found species described, which, in some points, seem to agree with the Iceland Gull; but these descriptions are so brief and obscure, at least so far as my ornithological research has been carried, that little accurate or full information from them can be obtained.

It would be superfluous to repeat here what was detailed in the paper already referred to, regarding the habits of this bird. I might simply state, that the observations then made, have been since amply and satisfactorily confirmed.

I have especially remarked, in this species, the absence of that instinct so conspicuous and interesting in its congenerous birds most allied to it in size and general appearance, which renders them so hostile to the sportsman, by warning other animals of his approach. It displays little of the activity or clamorous curiosity of many of its tribe; nor is it equally acute in detecting danger, though more uniformly reserved, and sufficiently cautious when its fears have been once excited.

The plumage is swan-like, very full; the down on the body considerable,—altogether rendering it almost impenetrable to any shot, but that of a large description. Of my previous knowledge of this circumstance, and of its characteristic partiality for carrion, I have successfully availed myself, to procure specimens, which otherwise would have been inaccessible to the fowling-piece.

It is generally observed to keep separate from other birds; and this fact is of itself a strong presumption of its distinction of species.

Its muscular vigour is peculiarly great, proportionally superior to that of the other gulls; and the power and execution of the bill are so formidable, as to compel one to be very circumspect in approaching it when wounded.

As in other species of this family of birds, individuals differ from each other in point of size; and, as far as I have observed, the male is larger than the female,—a remark which may perhaps be extended to other species of its tribe. From this difference chiefly, I was at one period disposed to believe that there occurred two species of Iceland Gull, having a relation to each other, analogous to that which exists between the Greater and Lesser Black-backed Gulls, and the *Larus fuscus* and *canus;* but subsequent observation is not so favourable to this opinion.

It is more perfectly an oceanic bird than perhaps any of the larger species of the genus; and from its habits might be regarded as forming, in some measure, a link between the more prominently defined Gulls and Petrels.

I have always observed this species to be uncommonly fat when it first arrives in Zetland, in autumn. Indeed, I hardly remember ever seeing any bird equal to it in this respect,—a circumstance which, together with that of the singular compactness of its plumage, and voracious avidity for carrion, first induced me to suspect this marine vulture to be a native of the higher latitudes. This conjecture was confirmed by accidentally falling in, at London, with a specimen of this gull, brought home by the Arctic expedition under Captain Ross, which agreed with the description I had given some years before, of the adult Iceland Gull; with this trifling difference, that there were scarcely any grey streaks to be observed on the head or neck,—a difference which might, indeed, refer to age, or climate, or season, but certainly could not affect the identity of species.

If the opinions, then, which I have suggested regarding this gull be adopted, they will present to ornithologists, of a numerous and very interesting genus, a well-defined species, before obscurely known, assuredly undescribed, as a British bird, and may authorise the trivial name of *Larus Islandicus*, by which I have proposed to distinguish it, as expressive, both of its Arctic haunts, and of the vulgar appellation by which it is known in the Zetland Islands.

XV.—*Notice relative to two varieties of* Nuphar lutea, *found in a Lake in Aberdeenshire.*

By Mr W. Macgillivray.

(*Read 9th February* 1822.)

One of the plants which form the subject of this communication, was, in as far as I know, first observed by Mr Glennie, teacher of drawing in Aberdeen, in July 1819. Not having seen the *Nuphar lutea* before, Mr Glennie took his specimens for that plant in its common form. There existed, however, a considerable difference in point of magnitude, which induced me to suspect, on first seeing his specimens, that they were not the same. I accordingly proceeded to the lake, where, besides the variety found by him, I had the pleasure of finding another, much more remarkable.

The Corby Loch, situate about three miles to the north of Don Bridge, near Aberdeen, is a circular lake, about half a mile in diameter, with brown water, such as we commonly find on the muirland districts. It is in general shallow near the edge, and rather destitute of vegetation, having merely the common species of *Potamogeton*, with *Litorella lacustris*, and *Myriophyllum spicatum*; but at the north and west parts, where it is deeper, there is abundance of *Scirpus lacustris*, *Arundo phragmites*, and other large aquatics, in the open places, between the tufts of which grows the beautiful *Nymphæa alba*, so rare on the east side of Scotland, and so very common in the Hebrides and West Highlands. On the north side of the lake are some patches of the plant found by Mr GLENNIE, while on the west side is abundance of another and more remarkable variety.

The two plants agree in possessing the following characters, which were noted from a considerable number of fresh specimens.

CALYX. Perianthium pentaphyllum, magnum, coloratum, foliolis obovato-rotundatis, concavis, patentibus.

COROLLA. Polypetala, minor; petalis patentissimis, cuneato-linearibus, erosis, dorso nectariferis.

STAMINA. Filamenta linearia, recurvata, quadruplici serie digesta, receptaculo inserta. Antheræ adnatæ.

PISTILLUM. Germen ovatum. Stylus brevis crassus. Stigma peltatum, elliptico-rotundatum, radiatum.

PERICARPIUM. Capsula corticosa, ovata, multilocularis, polysperma, (vix pulposa, hinc minime bacca vera).

SEMINA. Nitida . . . .

A person falling upon the two plants, at a distance from each other, would be ready to describe them as distinct species. He might thus imagine that three species existed in Scotland, whose essential characters might be as follow:

N. major, stigmate integerrimo elliptico.
N. media, stigmate repando sub-elliptico.
N. minor, stigmate dentato subrotundo.

In the true *Nuphar lutea*, or common form of the plant, the flowers are upwards of two inches in diameter; the lobes of the leaves are approximated, and even cross each other; the leaves are smooth, and their outline is regular, without sinuosity.

In the larger *Nuphar* of the Corby Loch, the flowers are generally about an inch and a half in diameter; the lobes of the leaves are also approximated; the back of the leaf is very slightly pubescent, especially on the lobes; the outline as in the last.

In the smaller *Nuphar* of the same lake, the flowers are not more than one inch across; the lobes of the leaves are widely separated; the outline is irregularly waved, or subangular, the lobes being distinctly angular; and on the back of the leaf there is a good deal of fine whitish pubescence, especially about the middle nerve, and on the lobes.

In the first, as has been said, the stigma is elliptical and entire; in the second, elliptical, but waved; in the third, rounded, and very distinctly dentate.

The difference between the common form of *Nuphar lutea*, and that of the larger variety of the Corby Loch, is not great, being observed chiefly in the size; and between the latter and the small variety, specimens occur of intermediate character. Hence, however different the common *N. lutea*, such as it is seen in the south of Scotland, and in the Island of North Uist, where it occurs in great perfection in the lakes near Loch Maddy, may appear from the diminutive *Nuphar* of the Corby Loch, it is probable that they form the two extremities of the same specific form.

The *N. minima* of Smith I have not seen; but it is to be observed, that both it and the synonymous *N. kalmiana* of Hooker, have precisely the character of the small variety of *N. lutea* mentioned above,—excepting in the case of the margin, which Smith describes as green. The species of

Nuphar, therefore, require to be more accurately determined. As to the petioles, they can furnish no character, being two-edged in all; and the approximation of the lobes of the leaves is scarcely of importance; the same, of course, must be said of the vinous odour.

It may further be remarked, that the specific name *lutea* is not the most eligible, when there are two species to which it might be applied with equal propriety; and the seed-vessel is by no means a *berry*, being simply a thick capsule, with pulpy dissepiments, but having no gelatinous or pulpy mass in which the seeds are imbedded. The nectaries on the back of the petals have not been noticed, in as far as I know; and the stigma can scarcely be called sessile, when between it and the germen there intervenes a neck of considerable size.

Many of our plants exhibit variations similar to the above, even in their native situations. The *Polygonum viviparum*, for instance; and the *Thymus serpyllum* loses its aromatic smell on the summits of the Hebridian mountains. *Nymphæa alba* experiences occasionally a similar diminution in size; and I have seen the leaf not more than three inches in diameter, but in this case all the parts retain their original form. It will not be surprising if at least some of the localities of our Scottish *N. minima* be found to present a diminutive variety of *N. lutea*. The observations, however, which are to determine this point, can only be made by those who have it in their power to compare the varieties, by studying them in their native situation.

XVI.—*Geognostical Sketch of Part of the Great Glen of Scotland.*

By Mr George Anderson of Inverness.

(*Read 12th January* 1821.)

In this communication I propose to give a mineralogical sketch of part of the Great Glen of Scotland.

This extensive valley cuts across the Island in the direction of NE. and SW. from Inverness to Fort William, and thereby forms the boundary between the middle and northern divisions of Scotland. Its bosom is adorned and enriched by the Lochs Ness, Oich, and Lochy; and the alluvial depositions that cover its surface constitute the bed of the Caledonian Canal. Its utmost length, from sea to sea, may be about 62 miles; and although Inverness marks its termination on the eastern coast, still the ranges of mountains that bound its sides do not stop exactly at that point, but run on for several miles, on both sides of the Murray Frith.

As the geological description of these mountains forms a principal object in the present communication, we shall trace them to their termination on the east, and then westward, to the central chains, at Fort Augustus.

Fortunately the view, from any of the heights above the town of Inverness, exactly embraces the whole circuit of these mountains, from their extremity on the NE. to that on the SW.; and it is, accordingly, to the objects included within this panoramic view, that I now intend to restrict my description. From these hills we observe, on the NE. side of the Frith, the entrance to the Bay of Cromarty; and passing the eye along towards the west, we find the coast skirted by a line of fine sweeping hills, whose course is interrupted at Kessock Ferry by part of the Beauly Frith. The same chain of hills is observed rising gently from the sea on the Inverness side of the Ferry, and, after forming the well-known Craig Phadric, we see them terminate, after a course of six miles, in the neighbourhood of Dochfour. At this point, which is at the lowest extremity of Loch Ness, we observe a change in the height, bearing, and outline of the mountains; and, with this change, which I shall afterwards shew to be both of physiognomy and composition, we can trace the continuation of the chain along the edge of the Loch, all the way to Fort Augustus. Here our view is bounded by the line of the horizon. Stopping, therefore, at this point, and then directing our eye to the south side of the valley, we discern a third range of mountains, running, opposite to the one we have just mentioned, by Boleskine and the Fall of Foyers, to Dores, a village situate at the lower extremity of this side of the Loch, and nearly opposite to the above mentioned point of Dochfour. Above this village another change takes place, both in the direction and character of the range; for, instead of pursuing their former course, in a line with the edge of the lake, the mountains deflect considerably towards the east, and, subsiding into a smooth and low ridge, which I shall afterwards shew to be composed of transition-rocks, they fall into the low grounds between Fort George and Nairn.

Such are the ranges of hills seen from Inverness, and which are connected with that portion of the Great Glen we are about to describe.

By extending the sphere of vision, we might have included the ranges of Ben Nevis and Strath Connon in Ross-shire, and those of Strath Glass and Strath Nairn in Inverness-shire, but these have no connection with the mountains of the Great Glen.

According, then, to the above statement, we shall have to describe, in the circuit seen from Inverness, four distinct ranges of mountains. The first of these extends from the entrance to the Frith of Cromarty to Dochfour. The second, from Dochfour, or rather from a point (called Phopachy, to be afterwards noticed) behind it, to Fort Augustus; the third, from Fort Augustus to Dores; and the fourth, from Dores, by the Muir of Culloden, to Fort George.

After describing each of these in the above order, we shall conclude with a brief examination of the alluvial matters contained in the intervening valley.

FIRST RANGE.—*From Cromarty to Dochfour.*

It may be observed at once of this range, that it is part of the great deposit of Red Sandstone, which has been so frequently described as skirting the whole of the east coast of Scotland, north of the Spey. Whether this red sandstone is to be considered of the same nature with that described as occupying so large a portion of the west coast, I am not able to determine, having never seen any of the rocks of that quarter. I may, however, observe, that, as far as my observation extends, no clay-slate or greywacke, similar to those which occur in the red sandstone of Sky and Applecross, are found on this coast. Nor does the red sandstone of the range at present under our view, rest upon or alternate with gneiss, or any other of the primitive rocks, as it is said to do on the west coast, unless it be near Dochfour, where it approaches mountains of gneiss and granite. Its relations in this direction, however, I have not yet been able satisfactorily to explore. I may also remark, before commencing the particular description of this sandstone, that it is in one spot (near Fortrose) covered by a small portion of secondary strata, which, although I have not yet examined, I conceive to be a mere prolongation of the secondary deposits of Morayshire. The other points of resemblance between this red sandstone and that of the west coast, may be gathered from the following description.

The principal range, or rather ridge, which skirts along the Ross-shire coast, rises to the height of from 300 to 500 feet, and presents an outline in general waving, frequently tabular, and, in one or two instances, broken into short and sharp peaks. The bearing is uniformly towards the east or north-east, and the dip is towards the west, varying, however, in regard to the magnitude of its angle. A similar uniformity of dip and bearing pervades the whole of the mountainous chains in this district; and it will perhaps save us the constant repetition of the same north-easterly tendency, if we here, once for all, refer to the natural position of the Valley of the Ness.

Of the ridge here alluded to, the acclivities next the sea are frequently precipitous; but, as might be expected, from the direction of the dip, the slope towards the interior of the country is much more gentle. Red Sandstone, which forms the whole of this ridge, constitutes also the whole of the peninsula called the Black Isle, lying between the Friths of Cromarty and Beauly, as also the land for a few miles round all the shores of this latter Frith. On the Inverness-shire side of Kessock Ferry, the remainder of the chain, to Dochfour, consisting of three or four hills, is formed of the same sandstone, and its associated conglomerate. The most conspicuous hill in this part is the beautiful and well-known Craig Phadric, on whose summit is situate the well-known vitrified fort. It gradually rises from the village of Clachnaharry, situate at the entrance of the Canal, to the height of 500 feet, and terminates in a tabular, or rather elliptical, summit, whose length is 220 feet, and breadth 100 feet. Towards Kessock, it subsides into two lower and mural tops; but its acclivities, towards Inverness and the Beauly Frith, are sloping, and highly cultivated. The highest top is surrounded by a wall of vitrified earth and stones. Where the masses are but partially vitrified *, we can discern them to be composed of the sandstone and conglomerate, which form the great body of the hill, as well as of boulders of granite, gneiss, felspar, and quartz rock.

To the west of Craig Phadric, the country, for many miles along the Beauly Frith, is composed of the same red sandstone. At the extremity of the Frith, however, its progress is stopped, by the approach of the granite and gneiss mountains of Ross-shire; and, in the Aird, the district lying along the south side of this sea, its uniformity is interrupted by the appearance of granite-hills at a place called Phopachy. These we shall afterwards shew to be the termination of the Second Range, namely, that running from Dochfour to Fort Augustus. This last range conse-

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* The vitrified surface does not exceed six or eight inches in diameter.

quently cuts across the line of the sandstone chain, and falls into the sea two miles behind Craig Phadric.

It is in a quarry in this direction, opened, near the village of Clachnaharry, for the use of the Caledonian Canal, that the rare and beautiful mineral foliated celestine occurs. It is found in the sandstone, in minute detached crystals, and in veins, and sometimes associated with calcareous spar.

Having thus noticed the general extent of country occupied by the red sandstone, it is now necessary to enter a little more particularly into its composition.

This red sandstone consists of minute particles of quartz, and a few scales of mica, either simply attached to each other, or connected by a basis of red, seemingly decomposed, felspar. Its coarser varieties form a conglomerate, which consists of pieces, both round and angular, of granite, gneiss, mica-slate, felspar, and common quartz, the whole being cemented by a hard basis of quartz. In many places the rocks are so exposed, that the transition from the coarse conglomerate into the fine sandstone can be easily traced; and when this is the case, the transition either takes place by a gradual diminution of the particles of the conglomerate, thereby passing into the sandstone, or by an alternation of successive layers of coarse and fine stone. Even sections of the same stratum or layer will develope these transitions. Sometimes one part of the mass will be of fine sandstone, and the rest of conglomerate, or unconnected portions of the conglomerate will be found completely inclosed in the sandstone. Frequently an immediate passage can be discerned from the coarsest conglomerate to the finest sandstone, and then the larger fragments appear sticking in the sandstone, as if they had been wedged into it. In regard to the position of these two substances, I have observed, that, although the sandstone and conglomerate frequently alternate with each other, the higher strata, or the tops of the hills, are almost universally formed of the conglomerate. This may, however, be owing to some external forces, which have swept away the softer and finer strata of the sandstone.

The strata of red sandstone are generally horizontal, but they are also very often highly inclined, and even perfectly vertical. They seldom continue for any great distance straight, but are often waved, the seams between the strata being incrusted with scales of mica. They differ widely in their hardness, thickness, and tendency to decompose.

Such are the results of my examination of this formation. Its junction with the other strata has hitherto eluded my research.

We shall now pass to the consideration of the Second Range, viz. that lying between Dochfour and Fort Augustus.

Second Range.

This chain, from its commencing at Phopachy, is not exactly conformable with the direction of the one just described. It crosses the red sandstone at a small angle, and, if its bearing were produced from Phopachy through Dochfour, it would terminate nearly at Dores, on the opposite side of Loch Ness. The mountains, accordingly, are not parallel with the margin of the lake, and appear rather to be joined together by their lateral planes than by their extremities. The mountains which compose this chain are distinguished from those of the red sandstone already noticed, by their greater elevation, some of their summits being 3000 feet high, by a bolder and more rugged outline, by steeper acclivities, and by a more uniform vertical position of the strata. The general form of the outline is waving, inclining to conical; but the undulations are shorter, and more numerous, than those of the sandstone.

The most conspicuous mountain in this chain, which is upwards of 20 miles in length, is Meaulfourvoney, distinguished by a single round, huge cap of granite; and the lateral valleys it contains are only two in number, namely, Urquhart and Invermorrison.

In tracing the strata of this range, from the shores of the Beauly Frith, we first met with several low hills, intersected by deep gullies, rising from the sea at Phopachy, nearly four miles to the west of Inverness, and trending in a transverse direction across the country towards the higher and more central mountains, along Loch Ness. These hills, which gradually increase in height as they retire from the sea, are all formed of a beautiful red variety of granite, in which the felspar and quartz greatly predominate over the mica, or of what Professor JAMESON denominates *granitic gneiss*. The structure is large, granular, inclining to slaty, and the strata are vertical.

As far as I observed, this granite contained no interposing veins, nor did it seem to possess any additional simple minerals besides those that enter into its own composition. Interposed between these granite hills and the sandstone strata formerly described, is a small tract of grey gneiss. Its existence can be but seldom traced on the side next Phopachy, owing to the quantity of peat and gravel formerly alluded to; but as we advance into the interior, it is more and more exposed; and, on arriving at the acclivity towards Loch Ness, its strata are completely developed in the course of Dochfour, or rather Dochgarroch Burn.

The water of this burn has cut through the rock, in some places to the depth of 100 feet, thereby forming a wild and narrow gully, in which the nature of the strata can be easily and perfectly determined. They seem entirely to consist of one substance, namely, grey gneiss. This rock is of a very soft nature, and hence is easily penetrated by frost and running water. It is disposed into thin strata, which do not rise much above the horizontal position, and are inclined, in this place, towards the south or south-east.

It would be useless to record any of the varieties of this gneiss, as they are but few in number, and depend only on the proportions and colour of the different ingredients. The most interesting circumstance attending these strata is the occurrence of granite veins. These are extremely numerous, and their courses are completely displayed on the sides of the gully. They seldom coincide with the strata of gneiss, but generally cut across their direction, at an angle variously inclined, rarely perpendicular. The granite veins vary in thickness from half an inch to two feet. These veins consist of a red or white, large, granular granite, similar in general to the granite just described, as occurring in the mass of Phopachy hills, but differing as to the intensity of the colour and lustre, as well as in hardness. This latter property is often so great, that I have observed the granite veins hanging over a precipice, after the softer gneiss has been swept away. Their colour also points out their direction among the grey strata of gneiss.

These veins afford a fine study to the geologist, exhibiting great variety of intersection, shifting, and branching; and although the gneiss near to them is sometimes contorted, it also exhibits the same structure where no veins are visible.

To these observations I have only to add, that the gneiss does not extend along the margin of Loch Ness above two miles. It then gives place to a small-grained granite, or granitic gneiss, which forms nearly the whole of the remainder of this chain up to Fort Augustus, and, consequently, the last substance we have to describe in this part of our circuit.

The grains of this granite, which are red, depending on the felspar, vary in size from small to very fine, even to microscopic; and when the rock occurs in this latter state, it might easily be confounded with sandstone. One hill, in fact, not far from Dochfour, which presents a red, crumbling declivity, might apparently be described as composed of red sandstone. An examination, however, of the rock in its original position would soon disprove this fallacy. After passing Maulfourvoney, this granite, which occupies the whole of this chain, at least on the side next Loch Ness, gives place to gneiss, which continues as the prevailing rock to Fort Augustus, and from thence all the way to the opposite shore of Lochaber.

The strata of the granite seem not to be very regular as to inclination and bearing, but their alternations with gneiss are frequent and distinct. Whether this rock is itself to be considered as a mere variety of gneiss, I have not yet sufficiently determined. As far, however, as my partial observation has gone, I have observed little of the slaty structure characteristic of gneiss; but, on the contrary, have almost always found the masses of these strata to be quite compact, and destitute of every appearance of regularity or alternation of the ingredients*.

Their hardness and compactness, in fact, seem to make them well adapted for building; and they have, I believe, been accordingly used in the construction of the locks of the Canal at Fort Augustus.

This mountain range, which may be considered as composed of granite and gneiss, also contains beds of granular foliated limestone, which are situated in the gneiss. The best known beds are those in Glen Urquhart. These beds contain foliated and radiated actynolite, fibrous tremolite, and disseminated iron-pyrites. The tremolite and actynolite occur also associated with a beautiful white variety of felspar, in the neighbouring strata of granite. None of the gems, except rock-crystal and garnet, have been as yet discovered in these mountains: but it is probable that zircon, and perhaps tinstone, might be found, by a careful and minute examination.

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* Professor JAMESON, I believe, considers the rock of this district as gneiss.

Having thus noticed the general characters of the range lying between Dochfour and Fort Augustus, we shall not trace the strata farther towards the west; but, in pursuance of the plan laid down at the commencement of this sketch, continue our description, by giving an account of the chain running along the south side of Loch Ness. This chain commences at Fort Augustus, and terminates near the village of Dores; it forms therefore the third chain we proposed to describe,

THIRD RANGE.

For the first eight miles, after leaving Fort Augustus, the mountains in this direction are principally composed of granite and syenite.

These rocks possess no great peculiarities of structure or position. They are not independent formations, but seem rather to be connected with the great ranges of primitive mountains that stretch across the island in a north-easterly direction from Lochaber and the borders of Argyleshire. I need not therefore notice them any farther, as any observations of mine (and they are as yet but few and imperfect) could only corroborate more accurate and better known descriptions. These mountains of granite and syenite are succeeded, near the celebrated Fall of Foyers, by a chain composed of quartz-rock. This beautiful rock has always been observed by the visitors of this romantic district, but its relations to the neighbouring strata (owing to the natural difficulty and extent of time requisite for the investigation of the subject) have not yet been properly ascertained. It would, in fact, require a person resident in the country, and well acquainted with its geography, to undertake such a labour with any hopes of success.

The outline of this chain is of a smooth conoidal shape, with regular and nearly equally undulating hills, which rise to a great height, and are extremely bare, from the thinness of the soil, and the hardness of the strata.

The quartz-rock possesses in general a brecciated or conglomerated character, and consists of portions of granite, gneiss, mica-slate, quartz, and felspar, united either by a white or a brownish basis of hard quartz; they also simply adhere or penetrate each other. In some instances, chlorite occurs instead of mica-slate; and it is not at all improbable that a minute examination would detect large beds of that substance.

Small specimens are seldom found to illustrate the distinguishing characters of this quartz-rock; but in large masses, the imbedded portions, both round and angular, are easily observed, and are seen to vary from the size of a pea to several feet in circumference. This conglomerated rock differs from the corresponding member of the red sandstone formation, by a fresher and more crystalline appearance, by a want of the general dark-red colour, by forming mountains of a higher and more broken outline, and by not containing any portions of true sandstone. I have only farther to remark, that this chain is also connected with the central ridges tending towards Badenoch; but that, in the direction of Loch Ness, it stops near the above mentioned village of Dores, which lies at the southern extremity of the lake.

FOURTH RANGE.

Resting upon, and immediately succeeding the mountains of quartz-rock I have just been noticing, there occurs a ridge of a lower and smoother outline, which commences above Dores, and, after passing, in a continued line, by the Muir of Culloden, gradually falls into the low lands situate between Fort George and Nairn. The bearing of this ridge tends more to the east than that of the chain immediately preceding it, and hence it does not lie in the prolonged line of the edge of the Loch. Consequently, between this ridge and the centre of the valley, which we may consider as the river Ness, there intervenes a space of from one to two miles. This space is covered by a series of alluvial matters, which, together with a similar deposit fronting the sea between Fort George and Inverness, shall be afterwards particularly noticed. At Dores, one or two hills occur, formed of red sandstone, and described several years ago: they are quite partial, and are to be considered as parts of the sandstone formation formerly described, as extending to the neighbourhood of Dochfour, on the opposite side of the valley.

This ridge, which forms the fourth and last chain in the circular view from Inverness, is known under the name of the Leys, and may be distinctly seen in its whole length from the rising ground immediately above Inverness. As seen from this position, the Leys seem to proceed from the borders of Loch Ness, or Strath Errick, and run in an uniform direction all the way to Nairn, where they are lost among the alluvial and sandstone formations of that county. The most singular character of this ridge, and the one which distinguishes it from every other chain in the country, is its unbroken outline throughout its whole extent, of about twenty miles.

The height of this ridge is from 300 to 500 feet, and the acclivities on both sides are gentle, and covered with a deep bed of alluvium. The cover of alluvial matter is so considerable, as in general to conceal the strata, thus leaving us as the only means of becoming acquainted with them, the inspection of quarries. Judging from these quarries, the whole range appears to be distinctly disposed in strata, generally slightly inclined to the horizon, and composed of slate-clay inclining to clay-slate, red sandstone, and occasionally conglomerate, sometimes bearing a considerable resemblance to greywacke; and, like some of the varieties of sandstone, bearing marks of being in part the results of a process of crystallisation.

In these strata, a few simple minerals are met with, such as arragonite, heavy spar, calcareous spar, and iron-pyrites.

ALLUVIA.

The mountainous ranges encircling Inverness, I have shewn to consist of gneiss, granite, syenite, quartz-rock, slate-clay, red sandstone, and conglomerate; and it now seems necessary, for their final elucidation, to describe the characters of the alluvial matters in the Great Valley surrounded by these mountains.

The principal part of this space is covered by the waters of the Moray Frith and Loch Ness, and the remainder forms the bed of the Caledonian Canal.

At Fort Augustus, the highest point of this extensive Valley, an alluvial collection, composed of the debris of the neighbouring mountains, spreads itself between the Lakes

Ness and Oich; and a similar bed of gravel, except where interrupted by Loch Lochy, can be traced to the opposite shore at Corpach, near Fort William. These alluvial deposits have always supplied abundance of materials, and a compact bed for the line of the Canal, while the absence of large masses of fixed rock contributed to render the work more expeditious. Another alluvial flat, free from large rocks, though otherwise rather loose in texture, occurs at the lower extremity of Loch Ness, between it and the sea, thus completing the track of this great Canal. All these alluvial beds are similarly constituted; and hence, by describing those in the immediate vicinity of Loch Ness, we may form a very good idea of the whole.

Between the Murray Frith and Loch Ness, these deposits arrange themselves into three flats or banks. The first and lowest, is the one through which the river Ness and the Canal run, and on which the greater part of the town of Inverness is built. Removed a little way back, but rising above this to the height of 50 or 60 feet, and occupying the space between the south bank of the river and the ridge of the Leys formerly described, appears the second flat, or table-ground. And, lastly, on the opposite side of the Ness, proceed, from the confines of Dochfour, a series of low, waving, and steep hillocks (not surpassing 200 feet in height), which terminate, after a run of six miles, with the celebrated Phorvaine, and Pomnahurich, or the Fairies' Hill. This last set of hills are inclined to the sandstone range bounding this northern side of the Valley, at an angle of from 30° to 40°.

Agreeable to this account, a person proceeding from the river towards the south, would first pass over the lower flat, which appears in the form of a beautiful strath, of from one to two miles in breadth; and then, after ascending a steep bank (of 40 or 60 feet in height), he would come upon a fine smooth plain, bounded on the south by the Leys, and containing on its surface many of the richest and most beautiful farms in the country. This second flat, which is the most interesting of the three, commences near Loch Ness, and runs all the way to Fort George, a distance of from 14 to 18 miles. It comes close in on the back of Inverness, forming the Castle-hill and the site of the ancient castle of MACBETH; and then turning to the east, it proceeds along the coast, towering above the sea, or retiring into sweeping and verdant banks. Its breadth between the Leys and the sea varies from one to four miles; but the most interesting circumstance attending it is, that a similar gravel bank, of the very same height and character, can be traced, with very few interruptions, along the whole of the Beauly Frith, and on the opposite shores of Ross-shire.

I shall now mention the substances of which these alluvial beds are formed. These consist of fragments of rocks belonging to the primitive and secondary classes, and they exhibit not only all the varieties found in the mountains of the neighbourhood, but also many that appear to have come from very distant parts of the country. Such are the white stone of Ben Nevis and Strath Conon in Ross-shire, and the quartz-rock of Foyers. The substances of this gravel occur in nearly horizontal beds, which vary in fineness from the smallest sand to round boulders of several feet in circumference. The most general size, however, of these fragments, is that of a man's head, or of a large cannon-ball. The rocks of which these are composed, are principally the following, viz. granite, syenite, gneiss, mica-slate, seldom or never clay-slate, varieties of primitive trap, green-stone, and felspar-porphyry; quartz-rock, chlorite-slate, white-stone, fresh common felspar, common quartz, and precious serpentine. Of the secondary rocks, I only observed red sandstone and its conglomerate, occasional pieces of white sandstone, but never any of the secondary porphyries or trap-rocks. Clay occurs but seldom, and hence the sandy nature of the soil in this district, and consequent badness of the crops in dry seasons. Marl has been discovered in one or two places, which were formerly the bottoms of fresh-water lakes, but which are now deeply incrusted with a layer of peat.

XVII.—*Observations on the Immer Goose of Zetland.*

By Laurence Edmondston, Esq.

(*Read 6th April* 1822.)

There are few birds to which anomalous and perverted instincts have been more ascribed than to the Colymbus Immer. It has been represented as incapable of flying,—as crossing boisterous oceans merely by swimming,—as hatching its egg under its wing, or forming its nest on the surface of the water. And nothing more clearly demonstrates the necessity of investigating patiently the habits of birds in their native retreats, than the fact of the singular improbabilities that have so long been mingled with our information of a species which, from its number and general diffusion, ought long since to have been correctly known.

The erroneous and fanciful opinions which relate to this species, seem to have been delivered either on obscure or credulous authority, or as loose assertions unsupported by actual observation, intended to account for what seemed to be difficult. And it does appear surprising, that the only supposition which obviously resolves or precludes these obscurities, should not have at once presented itself to minds in the least degree habituated, not indeed to closet, but practical ornithology.

In prosecuting this interesting branch of natural history, I was soon struck with the unsatisfactory and obscure opinions generally entertained regarding many species of the Colymbus genus, and more especially the Immer; and I early embraced the opinion, that this bird was merely the young of the Great Northern Diver: but I determined to confirm this by patient observation, and particularly by contrasting the two birds together, and it was not long before this opportunity was afforded me; it has since been frequently repeated, and has left no doubt on my mind of the accuracy of the opinion I had first formed.

The Immer is found during the whole year in Zetland, though in summer it is rather less numerous, and at this season it is most frequently met with in *single* individuals. Its nest has never been discovered, nor has its young been observed accompanying it. Its size and plumage in different individuals are various; its organs of generation indistinct.

These facts, taken in connection, prove, I think, this bird to be not yet arrived at an adult state; and they agree perfectly with its general description by naturalists.

That it is the young of the Northern Diver, is, I conceive, equally established in every respect.

I have examined specimens in all the different gradations of plumage, from the more imperfect appearance of the Immer till it had almost attained the beautiful and well-marked plumage of the *C. glacialis*. These specimens, apparently just passing into the adult state, were mostly observed during summer, and too early in the season to suppose them to have been the brood of that year. Those, on the other hand, which I have met with in autumn, were chiefly in that plumage most distant from the appearance of the Northern Diver. The size, general aspect, and voice of these two birds—their modes of swimming, diving, and flying, are precisely the same. They frequent the same situations, and live on the same food.

I have seen repeatedly, in Zetland, in autumn, and at that period when the young of the *Glacialis* might be expected to be full grown, and to arrive in that country (or, if hatched there, to appear in the bays), families, consisting of two northern divers and two immers, apparently inseparable, and the actions of each toward the other quite characteristic of the reciprocal relations of parent and young bird.

The immers, in this contrasted situation, seemed as large as the others, but did not swim so erect, or look so lively and active; and were chiefly distinguished by the absence of the white bars across the neck; they were also less easily alarmed. When fired at, the northern divers took wing with facility: the immers also, but apparently more reluctantly; and after flying for a short distance, soon alighted, when the others, as if unwilling to relinquish the care and protection of their offspring, dropped again beside them.

That the immer should use its wings less than the adult bird, is only what might be anticipated from the analogy of the habits of many of the species of this family, the young of which go to sea almost immediately after bursting the shell; and hence, being so early habituated to diving, as a resource of food and safety, seldom use their wings, but when driven to extremity, or to effect distant and dangerous migration. It is accordingly in autumn, immediately after their arrival in Zetland, that the immers are most frequently observed to fly. They are more numerous also at this season, when they are seen in companies of three or four individuals, and are usually more accessible than at other periods of the year. They then appear fatigued and emaciated, evidently from the effects of a long voyage; and are more intent in searching for food than providing for their safety.

It flies with rapidity and ease, though it generally prefers diving, to elude its pursuers. Its wings are very muscular, but it does not employ them to assist its motion under water, as some other birds allied to it uniformly practise *.

In Zetland, no distinction seems to be known between the Immer and the Glacialis, and, when the latter occurs, it is termed Immer.

The Colymbus Immer, therefore, is merely the young of the Great Northern Diver; and what here remains to be stated, applies equally to both birds.

I have little doubt that a few pairs of the *Colymbus glacialis* breed in the more secluded morasses or islets of Zetland; but these could not by any means supply the number which are met with at all seasons among these islands, where, indeed, it is rather a numerous species.

It is one of the most expert divers; and its movements in its native element are highly graceful. No bird with which I am acquainted can remain so long under water at one time. It is partial to sheltered and retired bays, though it is very often found in the more exposed situations, and is well calculated to brave the utmost fury of the storm.

It is never seen on land, even for repose, but only when wounded, or diseased. Its sleep is taken on the water, and seems often to be continued for some hours together: with its head under its wing, it may be frequently observed passively floating in the direction of the wind or tide, but always sufficiently on its guard against surprise. It is peculiarly fond of sand-eels (*Ammodytes tobianus*), and may commonly be expected to be met with where these abound.

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* The fact of this bird being able to fly, was, I believe, first stated by Dr Edmondston, in the first volume of the Transactions of the Wernerian Society.

The plumage on the body is so full, and the skin so thick, that small shot makes little impression when the back of the bird is not turned to the sportsman; and it is therefore the practice of the experienced to wait for this favourable situation, or to take aim chiefly at the head or neck. It dives with great celerity on the flash of the pan; and hence another precaution for securing its capture, that of waiting for the momentary dipping of the bill in the water,—a habit which most of the divers practise from time to time as they swim along the surface.

It is exceedingly tenacious of life. I have seen it even when mortally wounded, with its head literally shattered, and the brain perforated in various directions, still struggle to escape, with almost undiminished vigour and sagacity; and as it seemed impossible to kill it speedily, without unfitting it for being a specimen, the sportsman, relenting at its torments, has been compelled to put an end to them, by beheading it.

From its marked tenaciousness of life, and comparatively superior power of suspending respiration for a considerable time, I am disposed to expect some peculiarity of structure in its vital organs, and, with this view, shall avail myself of the first opportunity that occurs for its accurate dissection.

I am at present engaged in endeavouring to determine the validity of the claims of other birds of this genus to be considered as distinct species. So far as I have gone, I am disposed to consider the *Black-throated* and the *Red-throated Divers* as the same species; and I have no hesitation in asserting my belief of the *Speckled* Diver being the young of the latter. I once shot a bird quite corresponding with the description of the *Colymbus stellatus;* and on examining carefully the under part of its neck, I found several ferruginous feathers just shooting forth, and the bird, in other respects, beginning to assume the plumage of the Red-throated Diver. Another Speckled Diver has indeed been described, but I do not perceive that it differs in any essential respect from the *C. stellatus.*

If these views, then, be correct, we shall find only two distinct species, the *Colymbus glacialis* and the *C. septentrionalis,* where six separate species have been usually described.

Edinburgh,
1*st March* 1822.

XVIII.—*A Description of two New Plants of the Order* ALGÆ, *found in Scotland.*

By R. K. GREVILLE, Esq. F.R.S.E. M.W.S. &c.

(*Read 26th January* 1822.)

ECHINELLA, *Lyngbye.*

GEN. CHAR. Massa sub-gelatinosa, granulis solitariis, cuneatis, elongatisve, farcta. LYNGB.

Echinella circularis, *mihi.*

Echinella, filis simplicibus, strictis, longitudinaliter æqualibus, compactis, cuneatis, in circulo plano dispositis. Tab. viii. fig. 2.

HAB. In paludibus et rivulis lentè fluentibus, sæpe ad folia mortua, &c.

Individual plants very minute, but, from generally growing in considerable quantities together, the species is sufficiently conspicuous. It exists, either in dense masses, of a dull-green colour, with a slight submetallic lustre, or occasionally dispersed and attached to the stems of rushes and grasses, dead leaves, or any substance immersed in the water. The form is perfectly circular and plane; the filaments or bodies of which it is composed, numerous, wedge-shaped, and more or less translucent; towards the base generally, but sometimes in the middle, of each wedge-shaped filament, is a transverse line; but I have not been able to ascertain whether any separation takes place at that part. From its fragile nature it rarely happens that a complete circle is seen, but I have oftener than once obtained more than three-fourths of one. The circles are of different sizes, and the filiform bodies composing them of different diameters, and consequently some are more wedge-shaped than others; those of the same circle are, however, generally uniform. The colour is a greenish-yellow (as far as the coloured portion extends), but there is always a considerable part of each cuneiform body crystalline or transparent, which may arise from a collapse of the contents. In the centre of each circle or congeries of plants, is a circular unoccupied space of small diameter, which being invariably present, may perhaps be its place of attachment to the substances on which it grows.

Of this most singular genus, LYNGBYE, in his excellent *Tentamen Hydrophytologiæ Danicæ*, has described nine species. Mr ARNOTT and myself have ascertained three of these to be natives of Scotland, viz. *E. fasciculata*, *E. geminata*, and *E. paradoxa;* besides another, that may probably prove a new species.

Early in 1820, I found this plant in a rivulet near Dumbryden Quarries. Soon after, Mr ARNOTT met with it, and determined it to be new. I again procured it in March 1821, from watery places in the King's Park, Edinburgh.

GLOIONEMA, *Agardh*.

GEN. CHAR. Fila gelatinosa, tenacia, continua, intus longitudinaliter farcta sporangiis ellipticis.

Gloionema apiculatum, *mihi*.

Gloionema; fronde continua, filiforme, ramosa aliquandò fasciculata; granulis cylindraceo-oblongis; apicibus ramulorum incrassatis, apiculatis. Tab. viii. fig. I.

HAB. Ad saxa marina, ubi ab undis marinis fere semper inundatur.

This plant, which appears to have hitherto escaped the observation of botanists, grows in the form of small lax tufts, from half an inch to near one inch in height. The individuals which compose them are filiform, about as thick as a hog's bristle, of a yellowish or olive-green colour, extremely flexible, and yielding to the slightest motion of the water; and although very tender to appearance, they possess considerable tenacity. Each thread or stem is at first simple, and subattenuated at its base. It soon throws out a few branches (sometimes in a fasciculated manner), which are continued simple to the summit, where they are not unfrequently shortly forked. The apices of the branches are incrassated, of a darker colour, and terminate in a remarkable semi-transparent apiculus, which of itself is sufficient to determine the plant. The whole frond is filled with a gelatinous transparent mass, containing throughout its whole substance oblong and cylindrical granules, which escape by incision and slight pressure.

It adheres closely to paper and mica, and, if preserved on the latter, recovers its form on being moistened with water.

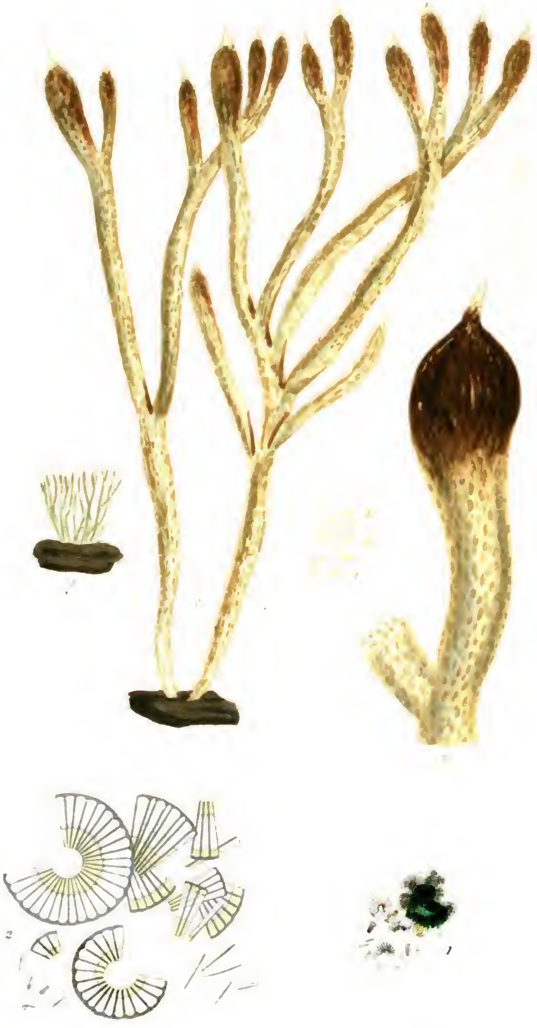
This plant does not appear to be unfrequent in the Frith of Forth. Early in March 1821, I found it, in company with Mr Arnott, on the Black Rocks at Leith; it grew there at the bottom of small pools left by the tide at almost low water-mark. I have since found it more sparingly between Newhaven and Caroline Park, midway between high and low water-mark, on rocks, and intermixed with young plants of *Ectocarpus littoralis*.

◆

Gloionema contains a small number of very extraordinary plants, which have puzzled every naturalist who has touched upon them. Of the two latest writers, Agardh and Lyngbye, the former has been most successful in establishing a good generic character: his own observation it may be worth while to transcribe.—" Species vere singulares et loco dubias continet hoc genus; neque satis scio, an revera tres illæ, quas huc congessi, unius ejusdemque generis sint, cum non nisi unicam vivam vidi, reliquas duas tantum siccatas. Multa tamen communia habent, sed adhuc dubium comprimere nequeo, an Gl. paradoxum sit vegetabile, nec ne."—*Aq. Syn. Alg. Scand.* p. xxxv.

Agardh has only described three species, *Gl. paradoxum*, *Gl. chthonoplastes*, and *Gl. fœtidum* (*Conferva fœtida* of Dillwyn). Of these, the first and the last I suspect can only be retained; the other (*Conferva* of the *Flora Danica* and Dillwyn, and *Oscillatoria* of Vaucher and Lyngbye), whatever genus it be referred to, must be excluded from *Gloionema*. Mr Gray, who, from the prodigious number of new genera he has himself, or in conjunction with others, manufactured in his late work, stands some chance of having a few of them adopted, has, from this singular plant, constituted a new genus, under the name of *Vaginaria*, a distinction which it seems really to deserve.

PLATE VIII. *Wern. Mem. Vol. IV page 217.*



GLOIONEMA APICULATA. ECHINELLA CIRCULARIS.

Delt *Wm H. Lizars Sculpt*

Lyngbye, in addition to the above Agardhian species, has described, under his genus *Bangia*, one decided *Gloionema*, viz. *B. rutilans* (*Conferva rutilans* of Roth. *Cat. Bot.* iii. p. 179.) His *B. quadripunctata*, if not truly *Gloionema fœtidum*, of which he is himself doubtful, also belongs to Agardh's genus, and perhaps also his *B. micans*, but of this I cannot speak with equal certainty.

The genus *Bangia*, if made to include those plants only which have the internal granules disposed in the form of transverse striæ, would be a very excellent one, and would comprehend all the species it has at present, excepting those I have named as belonging properly to *Gloionema*; it would be composed of *B. crispa, laminaria, fusco-purpurea, atrovirens*, and *mamillosa*, all of which have a distinct and common character.

B. laminaria has been detected in Scotland by Mr Arnott.

Explanation of Plate VIII.

Fig. I. *Gloionema apiculatum*.
  1. Tuft of plants natural size.
  2. Plants magnified.
  3. Summit of a branch of do.
  4. Granules.

Fig. II. *Echinella circularis*.
  1. Plants magnified.
  2. Do. very highly magnified.

Edinburgh,
20th January 1822.

XIX.—*Some Observations on the Natural History and Habits of the Mole.*

By the Rev. **James Grierson**, M. D. M. W. S.
Minister of Cockpen.

(*Read 9th March 1822.*)

The adaptation of the objects of Nature to one another, and to the state in which they are found to exist, must, to every intelligent observer, appear beautiful and striking. This is perhaps nowhere more conspicuous than in the structure and instincts of animals. Like all other things, however, it affects us the less forcibly in proportion as it is familiar and ordinary. There are many animal instincts and dispositions that would appear exceedingly curious, and in the highest degree interesting, were it not for their familiarity. Not to speak of the bee, the ant, the swallow, and many others well known, there is, I think, something exceedingly interesting in the structure and habits of the Common Mole (*Talpa Europæa* of Linnæus).

Had we never seen or heard of such an animal and its operations, and were we to be told by a traveller, that there existed in some distant country a little quadruped, covered with a very thick and soft down, which lived constantly under ground, forming to itself roadways below the surface, and travelling in them to the distance of 40, 50, 100, or even 200 yards, making these subterranean roads of just such a height and breadth as to be convenient for itself, and casting up in heaps the superfluous materials in its way, and forming to itself convenient and comfortable lodgings in the bowels of the earth, we should certainly think it a very curious, or perhaps an improbable narration. But this is nothing more than a description of the Common Mole, that little active animal which we all so well know.

As I have never actually witnessed many of the facts I am going to detail concerning the operations and habits of the Mole, I must state to the Society, that I take my information with regard to them from a most experienced and scientific mole-catcher, Mr ROBERT FLETCHER, gardener in Bonnyrigg, near Dalkeith. Mr Fletcher is a man of great ingenuity and accuracy of observation, and every dependence is to be put on his statements. He is the inventor, too, I would beg leave to observe, of a most important improvement in the construction of vineries, of which he has now had the experience for many years, and finds to answer perfectly. The improvement is the making of the vinery of a circular form, so as to enable the plants in it to enjoy the benefit of the sun's direct rays as long as that luminary is above the horizon. He finds this so advantageous to the fruit, that he never misses an abundant crop of grapes, and those of a quality superior to what are usually produced in houses of the old construction. General DURHAM of Largo, and Mr MILLAR of Arnock, have both had grape-houses constructed on Mr Fletcher's plan, and find them perfectly to answer. I have also seen other inventions by him of great ingenuity and utility,—particularly a sort of rake, connected with a roller, for the purpose of breaking down, pulverising and cleaning rough ground, which I would term a Regulated Harrow; and a conical windlass, which works by a rope thrown two or more times round it, joined again at the two ends, and running in a moveable block suspended below the roller, and to which block the weight to be raised is attached. This invention is extremely simple, and deserves to be universally known. It is perhaps the most powerful mechanical contrivance that has ever been thought of, and is found to answer extremely well for rooting out trees. I think it should be named *Fletcher's Conical Windlass.*

But to return.—The size and exterior appearance of the Common Mole is so well known, as scarcely to require description. We all know it to be a little quadruped, of five or six inches in length, covered with a soft fur-like down, and of an iron-black colour (white individuals sometimes occur), the feet being exceedingly short in proportion to its body; the fore ones much larger, stronger, and more muscular, than the hind ones. Indeed, the mole can scarcely be said to have any fore legs. The feet seem to be fixed to the sides of the animal, without the intervention of legs. Each foot is armed with five claws or fingers, fortified with long horny points, the middle claw being a little longer than the rest, somewhat analogous to the human fingers. The fore-feet are almost twice the breadth of the hind ones, exceedingly strong, and well calculated for digging in the ground. The snout is long, and very much in the shape of that of a hog; the under jaw being extremely short in proportion to the upper one; or, I should rather say, that a flexible snout or proboscis projects about half an inch beyond the under jaw. The head seems fixed to the body, without the intervention of any neck. The tail is about an inch long, and covered also with down. It is observed, of almost all animals, that the colours of the belly, or that side of the animal which is usually towards the ground, or shaded most from the light, are of the faintest hue. In the mole, this distinction is, I think, less observable than I have noticed it to be in any other. Its belly is very little, if at all, lighter than its back. This may be owing to its being almost all equally exposed to the light, or rather all equally excluded from it. The male is considerably larger than the female. They couple in the month of March, and the female brings forth in May. She produces usually six or seven at a litter. On some occasions they seem to breed twice in the year. Mr Fletcher has seen young moles in September, but this, he says, is rare. The new-born moles are quite naked and red.

The males often engage in fierce combat with one another, particularly in the spring season. Mr Fletcher has witnessed this, and seen them seize one another with their teeth, and push and scratch violently with their claws, till both were much torn. He observed another curious fact lately, in the Duke of Buccleuch's Park, at Dalkeith. He found a male mole caught in one of his traps, and the entrails of it torn out, apparently by another mole. A few minutes after, he observed a mole moving along the track, or run towards the trap, and killed it with his foot. On taking it up, he found it to be a female. The same day, and near the same place, he found another male caught, and in the same state as before described; and he killed another female in the same way coming towards it. Had these affectionate and disconsolate wives thus torn their husbands in endeavouring to extricate them from their disastrous situation? Or are we to suppose them actuated by a different sentiment,—full of anger at their silly mates for being so stupid as thus to fall into the snare?

Each of the males, when taken up in that torn state, were still warm.

The mole constructs a snug, comfortable nest, in which to deposit her kittens. It is commonly found in a grass or corn field, about even with, or at no great distance below, the surface of the ground, and formed of grass, moss, stubble, or whatever else the field produces. It is always, of course, covered above; and, to prevent the rain from penetrating through the roof, there are placed on the top of this two drains or gutters, at right angles to one another, formed of consolidated earth, and having a gentle slope, in all the four directions, away from the nest. A jakes, or place for retiring to when about to evacuate the fæces, is always found at a little distance from the nest, say nine or ten inches distant.

The food of this animal seems to consist mostly of the common earth-worm, and it is in pursuit of these that it makes such mighty efforts in the formation of its subterraneous roads, and thereby often annoys so greatly the gardener and the farmer. The worms themselves often perceive the approach of their enemy, and struggle to escape from him. Mr Fletcher has seen them flee from the mole, and the latter come out of the ground after them, and catch them. But moles seem to prey upon other animals besides the worm, for this same observer once saw a mole that had seized a frog, and was killing it.—It is commonly thought that the mole goes every day to the water to drink. Mr Fletcher, however, doubts the truth of this very much. After many years observation, with the best opportunities, he has never once seen them drink. He is likewise disposed to believe, that they do not void urine separately from the fæces; but as dissection shews that this quadruped, like every other we are acquainted with, has a urinary bladder, the above opinion is rendered less probable. At all events, as a proof that the moles do not go every day to the water, Mr Fletcher tells me, that his father (who followed the same profession with himself) and he found them on the top of Arthur's Seat, at a great distance from the nearest springs, or any water. Probably the reason why the moles have been thought to go every day to the water, is, that their workings are often found near the sides of rivers or rivulets, or in the moist parts of fields, particularly in dry weather. But this arises from their finding most worms in those situations.—It is observable, that the moles make always greatest havoc in the way of throwing up hillocks or heaps in the winter season, or in the coldest weather. This arises from the necessity under which they find themselves in such a case to construct their runs, bores, or roadways, at a greater depth; for the worms in the winter season, or in cold weather, keep far below the surface, so that the moles, in following them, must go farther down, and of course have more occasion to throw up earth. In summer, when the weather is warm, and when there is enough of moisture on the surface of the ground, the worms are on, or near it; and then the moles, in hunting them, run among the roots of the grass, and have no occasion to throw up hillocks. For the reason why they ever do so, is this. They do not engage in the work as a matter of choice, or of amusement, or of wanton mischievousness; but of necessity, in the way of procuring their daily food. When they are a considerable way down, say three or four inches, for they seldom go deeper than about twice that distance from the surface, they are then unable to move all the earth immediately above them, and must, in order to get forward in their work, contrive some plan of clearing away the materials they detach. The plan they adopt is the following. The mole forms an upright, or rather a sloping shaft, and, as he detaches the earth with his strong fore-claws and snout from the front of the run or drift that he is making, he pushes it backwards, in successive quantities or loads, as we may call them, to the sloping hole or shaft which he had opened, and by main force, and successive efforts, heaves it up till it forms a hillock,—imitating, in this way, pretty exactly the operations of colliers and other miners; except that these employ machinery to bring their materials up the shaft, whereas the poor mole has to push all up by mere muscular exertion. A mole makes his bore very little wider than himself, and, in working, he seems to drag his materials backwards toward the shaft, and then push them up. He can, however, at certain places, readily turn himself in his road; and he can run along it with his back downwards, very nearly at the same rate as when he has it up. Mr Fletcher has often taken moles in his traps in this inverted position. It may be thought surprising how much work one of them will do in a short time. He will throw up six or seven heaps or hillocks in a single night, each of them not weighing less, by estimation, than six or seven pounds, so that he may be said to remove forty or fifty pounds of earth in a night. And it is observable, that, however hard the ground may be in which he is digging, the claws are always as sharp as needles.

As the heaps thrown up by the moles, and the roads they make among the roots of the plants and the seeds sown, are both great deformities, and injurious to the productions of the garden and the field, it is an object of considerable importance to know the best and surest method of catching or killing these animals. Three different methods have been thought of,—poisoning; watching the mole at work, and coming upon it with the foot or some instrument; and setting a trap for it. The first, I believe, is seldom had recourse to; though I understand it has sometimes been tried, and is said to have succeeded. But as I have had no opportunity of reducing it to the test of experiment, nor of seeing any one who has, I cannot pretend to describe it. I have seen the following recipé for poisoning the mole; but as I have not tried it, nor heard of any one who has used it, I can say nothing of its merits:—"Take a handful of oatmeal, and pour so much water on it (stirring it all the while) as to bring it into the consistence of porridge, or thin brose. With every English pint of this, mix ten grains of corrosive sublimate. Pour a small quantity of this mixture on a piece of board, and lay it close by the mole's hill. Drop on it twenty drops of the oil of rhodium, or of the oil of thyme, which has had a grain or two of musk mingled with it. The poison is to be put down at night, and in dry weather."—It is not likely that this should answer, as the mole is a carnivorous animal; but perhaps it sometimes, like the dog, takes vegetable food.

In the "New Monthly Magazine," for March last, No. 15. (published in London), I observe the following notice concerning moles.—"A gentleman," says the writer, "who was troubled with these animals in his garden, adopted the following method by way of experiment. Having opened one of the runs or trenches, he introduced a small quantity of rosin and sulphur, and, when in a sufficient blaze, covered it over with the mould drawn from the trench. Whether suffocation ensued, or (what is more probable) the fumes were highly offensive to the finer instincts of these animals, the purpose was completely answered; as they never afterwards made their appearance."

A top-dressing of quicklime will sometimes clear a field of moles. Mr Fletcher once saw this effect very strikingly accomplished in a field of Captain Preston's, at Gorton. It was quite over-run with moles; but after the liming, they all disappeared; probably in consequence of the lime having destroyed the worms on which the moles feed.

The mole may often be killed by watching it at work, or when it is engaged in forcing up the materials it digs out of its run. If you can then suddenly get in below it with a spade or hoe, you may throw it out, and destroy it; or you may come upon it with your foot, and fix it in the ground, till you get it thrown out by some instrument. To accomplish this, you must watch till you see the hillock where a mole has been recently at work begin to heave, and you must ascertain, at the same time, in what direction the mole is going. For example, if she appear to be carrying on her operations, or making her road towards the east, you may be sure she is, when you see the hillock move, pushing her materials towards the west; and, therefore, in order to secure her, you must turn your back to the east, and then tread hard and heavily on the east side of the hillock. You will then most likely fix her. But if you come on her the contrary way, she will turn back in a moment along her roadway, and escape. Some have employed, with good success, to kill moles at work, a board, either of a square or circular form, containing about 100 square inches, fixed on the end of a stick a few feet long, and stuck full of iron-spikes four or five inches in length. This instrument, plunged right upon the heap or hillock when the mole is seen to work, can scarcely fail to destroy her. But in order to catch a mole at work, the greatest softness of approach is required. It is scarcely possible, such is her acuteness of hearing or feeling, to get at her without throwing off your shoes, and walking in your stockings, unless it be near by the side of a road, or other place, where there are constantly noise and shaking of the ground, by means, for example, of horses and carts, or carriages, passing and repassing; and then the mole may be approached when at her work with great freedom. She does not take the alarm.

But the most usually successful method by far, of destroying the mole, is by means of traps, and of these there are various constructions. That used by Mr Fletcher (and he makes these traps himself) is very simple, and so perfect in its kind as scarcely to admit of improvement. The prime cost, too, he tells me, of each of his traps is only threepence. It consists of a piece of wood four inches and five-eighths long, two and a quarter broad, and about a quarter of an inch thick, with a hole a quarter of an inch diameter in the middle of it, and a slit or mortice cut transversely an inch long, and one-eighth wide, within half an inch of each end of it, leaving at each end of this transverse slit or mortice about half an inch; into which space, at each end of the slit, are fixed the extremities of a strong double iron-wire, so as to form a circular arch, or almost a ring of two inches diameter. A plug of wood, an inch and a half long, is made to fit the hole in the middle of the board, and is employed to act as a trigger; for it is put in when the trap is set, only so gently as to be removeable on the slightest touch. Two pieces of good brass-wire, deprived of the temper, and then formed into two rings of three inches diameter, are each fixed to one end of a piece of strong well-made fishing-line, or gardener's line, of eighteen inches long. The line thus armed, is doubled in the middle, and a knot cast on the double line two inches from the rings. These wire-rings, in this way, when laid together, exactly correspond with one another. A small piece of line, about an inch long, is fixed to the other, at the knot. I may mention, that the trigger is also fixed to the board by a piece of line tied round it, to prevent it from being lost. Things being thus prepared, the brass-wire rings attached to the ends of the line, are put each of them through one of the slits in the board, and fitted in betwixt the sides of the double iron-wire rings, so as to correspond with them, The small piece of twine attached to the knot on the double line is then put through the hole in the middle of the board, and the trigger is put in on the other side of the board, or that in which the double iron-rings are (viz. the under side of it), so as to prevent the bit of twine from being drawn back again. The board or trap thus prepared is now put into the mole's track or run, and fixed down by two pieces of wood eight or nine inches long, sharpened at one end, and having a cleek or hook at the other. Then a piece of a green or fresh stick three feet long, and about half an inch thick, is stuck into the ground by one end, at such a distance, as that, when bent down, the other may be over the middle of the trap. This is the spring. Holly answers very well; but Mr Fletcher finds that a rod of common lilac forms the best spring, this wood preserving its elasticity much longer than any other. The doubling of the line is then put over the end of it, and so the trap is set. As soon as a mole comes along the track, and touches the trigger, the small piece of twine, which by means of it held down the spring, is let loose, and so the spring acting pulls up the brass-wire-rings attached to the ends of the line, and the mole is thus caught by the middle, and killed, being squeezed against the board.

The grand secret of mole-catching, by the trap, is to find out an old run or roadway, for such the animals seem frequently to pass along. Each mole, or couple of moles about the time of breeding, seems or seem to have a particular track or district of road, below ground, which they frequent, and from which, at the most convenient places, they make drifts or runs, in pursuit of worms. An old run is often found along the side of a hedge, or of a walk in a garden, or of a box-edging, or the like. In a field, it is detected not unfrequently between two sets of hillocks. A run may often be discovered by thrusting into the ground any small sharp instrument, such as a common garden-weedock; and that in which you place your trap, should, if possible, be not more than two or three inches below the surface of the ground. When the run lies deep, it becomes inconvenient for setting the trap. A little experience will soon enable you to discover an old run or track.

It has been questioned by some whether moles have any organs of vision; but that they have, must now be universally admitted. Their eyes are, however, exceedingly small; and it may be thought that, from the usual mode of life pursued by these animals, the sense of sight can be of little use to them: yet there are facts to shew, or, at least, to render it very highly probable, that they see to a considerable distance. I have been favoured with one very remarkable fact of this sort, by the Reverend WILLIAM MACRITCHIE, minister of the parish of Clunie, in Perthshire, a member of this Society. It would seem to prove, that moles have a much more extensive sphere of vision than might at first be imagined. The account of the fact alluded to, as transmitted to me in a letter by Mr MACRITCHIE, is so full and satisfactory, that I beg leave to copy his *ipsissima verba*. Indeed I should not in any other way do justice to the subject.

" *To* Dr GRIERSON.

" *Manse of Clunie, 25th March* 1822.

" DEAR SIR,

" I HAVE your favour of the 19th current, and, in reply to your queries respecting the Mole mentioned to you by our friend Dr BAIRD, I beg leave to state the following particulars.

" Though the fact, alluded to by the Principal, did not fall under my own observation (it having happened about two months previous to my coming to reside here), it was repeatedly confirmed to me by the verbal testimony of three honest men, on whose veracity I had no hesitation in relying. They all three saw the mole, handled it, examined its eyes, &c., but did not observe whether it was a male or a female. Two of the men are since dead; the third is still alive, and has been my next-door neighbour for these thirty-seven years past: and had I had no other authority but his own for the truth of the fact referred to, I should have regarded it as altogether satisfactory. He has been long settled here as gardener and nurseryman to the Earl of Airly,—has himself been the death of many moles in his day, and was himself the death of the very individual mole in question. He has this very day, and not an hour ago, told me, that he recollects the circumstances that attended its death, more perfectly than many thousand things that have happened to him since.

"It was in the year 1785, within a day or two of the summer-solstice, on a calm, mild evening, between nine and ten o'clock, when the surface of the lake was as smooth as a mirror, he, and another of the men above mentioned, had rowed about fifty yards from the island towards the mainland, when they observed the creature steering its course from the mainland towards the island, and approaching to their boat. The gardener took off one of the oars, arrested the poor little voyager on its passage, struck it with the oar, killed it with the stroke, took it up, and handed it to his companion in the boat. Next day they shewed it to the other man, when all the three became, for the first time, converts to the belief, that moles could swim. The animal was killed about 100 yards from the mainland, and about 50 yards from the island.

"Previous to this interesting catastrophe, molecasts had been observed on the island, and the people were at a loss to account for them. I have myself repeatedly observed them there: and it is consistent with my own personal knowledge, that two moles have been trapped on the island within the last two years, one by our mole-catcher, and another by a son of the gardener.

"The island, since the commencement of my incumbency here, has been frequently overflown. I remember, one year, the whole surface of the island lay, for nearly twenty-four hours, under water, from one foot to eighteen inches in depth. Whether the whole race of moles then existing on the island might have shared the fate of the Antediluvians, or not, I cannot tell. It is not unlikely that a remnant (as in the days of Noah) were saved, since my friend the gardener (Alexander Duff) finds a difficulty in getting them extirpated. It is, I think, by no means improbable, that these curious animals carry on a sort of clandestine intercourse betwixt the mainland and the island.

"These few particulars, stated and authenticated as above, may serve so far to corroborate and illustrate some of your remarks on the history and habits of the *Talpa Europæa*, which I should like very much to peruse. I mentioned the above circumstances many years ago to my worthy deceased friend Mr ARTHUR BRUCE, who was some time ago secretary to the Natural History Society of Edinburgh; whether he published them or no, I have not learned *. In the mean time, if you find them of any service to you, *his utere mecum*; and believe me to be, with cordial wishes for your success in every laudable investigation,

"DEAR SIR,

"Yours sincerely,

"W. MACRITCHIE."

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* Since this paper has been put to press, I find, on looking into the Transactions of the Linnean Society, vol. iii. p. 5., that a short notice of the above curious fact was sent to that Society, in 1792, by Mr BRUCE. See also SHAW's Gen. Zoology, vol. i.

Though the very interesting fact, here so well stated by Mr MACRITCHIE, would seem to prove that the mole has an extensive range of vision, other facts appear to render this doubtful; for Mr Fletcher, to whom I have so often referred, tells me, that he has frequently thrown live moles into the water, but he never saw them on these occasions make for the land. They always swam round and round, as if they knew not where they were.

It is evident, that, if the mole had large or prominent eyes, they would be exceedingly inconvenient for it, and very liable to be injured during its operations under ground. They are, therefore, not only extremely small, but deep-seated in the head, and provided with a protecting film or integument, which the mole can bring over them, or withdraw, at pleasure. When this covering is withdrawn, which takes place when we throw a live mole into the water, the eyes may be distinctly seen like two black and shining points. GALEN, in ancient times, even without the help of the microscope, did not hesitate to affirm, that the different humours of the eye of the mole, and their respective tunics, could be seen; and though Sir THOMAS BROWN, and others, have denied the truth of this affirmation, yet we have the fact of the existence of these humours and tunics confirmed by Dr DERHAM. He tells us, in his "Physico-Theology," that he had made "divers accurate dissections of the eyes of moles, with the help of microscopes, having a doubt whether what we take to be eyes were such or no; and, upon strict scrutiny, could plainly distinguish the crystalline and vitreous humours, and the ligamentum ciliare, with the atramentaceous mucus."

If a mole be taken alive, either by digging or otherwise, it usually, at first, utters a sort of small scream, or blowing noise, and prepares for defending itself by its teeth and claws. A slight blow seems sufficient to kill it. The mole appears to be by no means tenacious of life, differing greatly, in this respect, from the class of reptiles. A mole is not easily kept alive in a state of confinement; it soon perishes, unless it can be constantly supplied with fresh damp mould in which to conceal itself. It is surprising how rapidly it will effectuate this, even on a soil that is tolerably firm. In a grass-field or plot, where the soil is light, a mole will hide itself almost in a moment; and they have been known to penetrate, and completely cover themselves in, a hard turnpike-road in the space of five minutes.

The following very curious and interesting statement concerning two that were taken alive, has been obligingly communicated to me by Mr Stark, a member of our Society.

" About four years ago," says this gentleman, " one morning early in summer, I caught a mole, which was running on the ground before me, for the purpose of shewing it alive to the children. On carrying it home in a botanical box, I put it into a large flower-pot full of moist earth in the greenhouse. It made its way instantly under the soil, and I placed a thick board over the surface of the pot, to prevent its escape. On returning, however, a short time thereafter, the board was overturned, and the mole had guttered the earthen floor of the greenhouse in many places, and was hard at work in a corner, where the earth was less consolidated. It was now replaced in the flower-pot, and another of nearly the same size inverted over it, which proved a sufficient barrier. Meantime one of the children had dug up a few worms, and the covering was removed, to see if the mole would eat them. It remained below. One or two of the worms were then dropped on the surface, and in a few seconds a heaving of the earth in the pot began, and the mole peeped out its head, apparently smelling for the worms, which having caught its notice, it immediately seized one and began to eat, though without entirely leaving its hole. Finding no danger to arise from this essay, the little animal grew bolder, came up full to the surface, shook the dry dust from its glossy coat, and began to eat with great avidity the worms which were successively laid before it. While thus occupied, I stroked down its back gently with my hand. At the first touch or two it seemed a little afraid, and shewed an inclination to retreat, though it did not intermit its eating; but gaining more confidence, it allowed itself to be patted without fear, erecting its short tail like a cat, as if the smoothing of its fur gave it pleasure. Its eyes were at this time, as on all occasions when it came to the surface, open, and it seemed to use them in the selection of particular worms, when more than one were placed before it. We were much diverted with its mode of eating. When it fixed upon a worm, it seized one end in its teeth, and taking it writhing with pain between its fore-feet, it stretched out its folds by little and little as it swallowed it, by a constant action of the feet, perhaps for the double purpose of freeing the worm from soil and untwining its convolutions.

“ This was in the morning. Occasional visits were made to the mole in the course of the day; and it grew so accustomed to these, that no sooner was the covering pot removed, and it heard the children's voices, than it came up to the surface for its food. Though it occasionally peeped over the edge of the flower-pot on these occasions, it did not attempt to leap from its place. Towards evening, from a desire to become still better acquainted with the little animal, it was put into a box, in which was a turf, sand the open side of the box was secured by a piece of wire-grating. The mole, however, did not relish this sort of confinement, and endeavoured to escape through the apertures of the wire. After some slight experimental attempts with its snout and fore-feet, it at length placed the latter between the perpendicular bars of wire, and turning them outwards, in the direction it employs them when digging, it inserted its sharp snout between the feet in the manner of a wedge, and, by a simultaneous exertion of its muscular force, bent the wires with great ease. The manner of its attempt struck me at the time, on account of its singular combination of mechanical powers. The insertion of its head between the feet gave it the power of a wedge, while, at the same time, it served as a fulcrum for the lateral exertion of the strength of the short limbs. It repeated this so often, when repulsed at one place going to another, that the greater part of the wires were bent; and, seeing no hope of confining it in this manner, and it having acquired the sympathy of the little spectators in its exertions for liberty, it was resolved to set the prisoner free, and to restore it to its native vale again, which was done the same night.

"Two years after, I brought home another mole one evening, in autumn; but not having the same convenience, it was placed in a large earthen jar, in the bottom of which was a quantity of dry earth. Worms were procured, and the mole fed in the same manner as before, though by candle-light. It burrowed in the earth freely, and came up for the worms which were laid down; but it was unfortunate that the earth happened to be quite dry, for, whether from this circumstance, or owing to its confinement in the jar, and being kept covered up in the atmosphere of a room, it was found dead next morning on the surface of the soil.

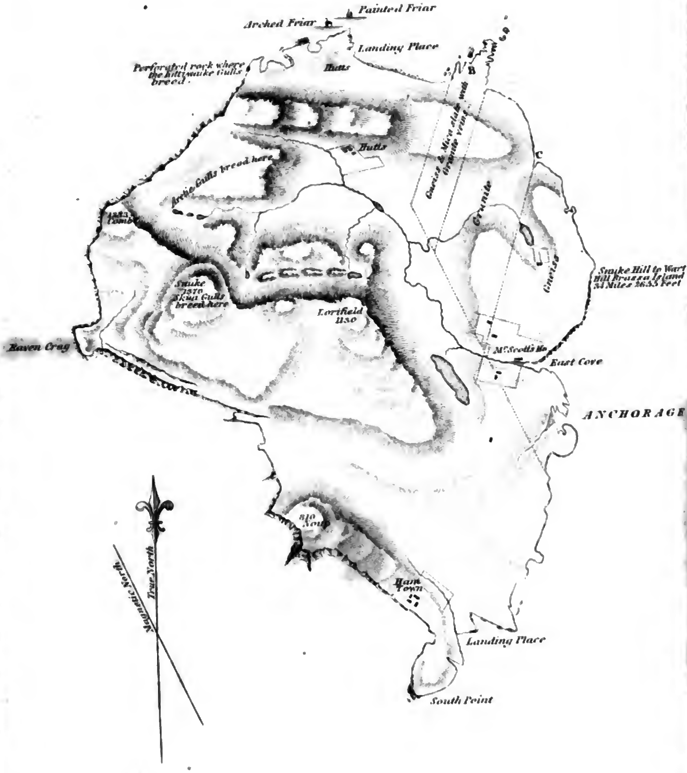
"The quantity of worms devoured by these moles was great, and more than I should have conceived it possible for such a small animal to eat at once. Both were apparently full grown.

"I may mention, if the circumstance be worth noticing, that the first mole had freely voided urine in the botanical box in which it was carried home."

The fate of the last of these two moles that were thus caught, and observed by Mr Stark, corroborates what I have before mentioned, with respect to the difficulty of preserving the animal alive in a state of confinement: and what he says regarding the first of them having voided urine in the botanical box, is a complete proof that the mole does not in this respect differ from other quadrupeds.

As the object of the mole, in all its operations, is to obtain supplies of food, it is not found in pure clay or sand, but in such mould as is frequented by worms, and the species seldom occurs except in cultivated countries. We do not meet with it in parched deserts, nor in the frozen regions of the north. The epithet *Europæa*, given by Linnæus to this species, must not be understood as indicating that it is found in Europe only, for it has been traced also in some parts of Asia and Africa. The soil of Ireland is still exempt from it, as well as from toads and serpents of all kinds. The flesh of the mole has very much of the savour of that of the rabbit, and is esteemed a great delicacy by the Arabs.

ISLAND OF FOULA.



W. H. Lizars Sculpt

XX.—*Account of the Island of Foula.*

By Capt. Vetch, of the Corps of Royal Engineers,
M.W.S. M.G.S. &c.

(*Read* 18*th May* 1822.)

The Island of Foula is the most western of the Shetland Islands, and, from the grandeur of its form, and secluded situation, has attached an interest to it, which a nearer inspection serves but little to diminish. As seen from the sea, at a few miles distance, its appearance is of the most imposing nature,—for though little more than three miles in its greatest dimensions, it rises boldly to a height of 1370 feet, and presents, along its western shores, perpendicular cliffs that seldom fall short of 600 feet, and in one place attain an elevation of 1230 feet, forming a scene perhaps not surpassed in grandeur by any in the British Islands. The mountain-ridge which stretches across the centre of Foula, and which chiefly characterises the island, bears some resemblance to the rock of Gibraltar. The length and height of both ridges are nearly the same; both present three prominent points or peaks, and both terminate at one extremity in perpendicular cliffs of nearly equal height.

From the summit of the Snuke, the highest and central peak of the ridge, an extensive view of Shetland is obtained. The Ossa Skerry, a remarkable detached rock, and Ronas Hill *, forming interesting features on the left of the scene, —while Fitfull Head and Fair Isle, objects of no less interest, terminate the view on the right hand, including a space of about seventy miles, chiefly occupied by the Mainland of Shetland. In very fine weather, five hills in Orkney may be descried, appearing like clouds in the horizon, but to the naked eye giving no clue to their identities. From these hills, however, the Island of Foula assumes an appearance not to be mistaken. Its precipitous west end, as seen from Westra in Orkney, at a distance of seventy miles, forms a striking object.

The Island of Foula is about fifteen miles from the nearest point of the Mainland of Shetland, and from Lerwick about thirty miles in a straight line, and in a direction nearly west: its greatest length is 3½ miles, and greatest breadth 2½ miles. The island is divided into two portions of nearly equal extent, by the mountainous and flat ground. Besides the mountainous ridge I have already mentioned, the Noup occurs as a detached hill in the south, rising very steeply to a height of 810 feet, and terminating in a round summit. This hill, though of the same height with Arthur's Seat, becomes a feature of minor importance in the vicinity of the Snuke. The mountain-ridge which occupies so large a portion of the island, has its general direction about 60° W. of N., being about a mile and a half long, falling very abruptly to the north, and with a gentle slope to the south, till it terminates in precipices at the coast, the external form of the mountain

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* Conjectured to be a corruption from Rue-Ness Hill.

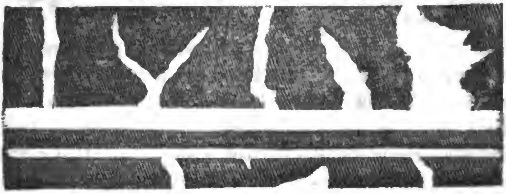
conforming in a general way with the tabulæ of the sandstone of which it is composed. An elevated platform, about 600 feet high, projects to the north from the west end of the ridge, and terminates abruptly at the north-west point of the island; and when viewed from the east, a few miles at sea, the last mentioned point, with the three peaks of the Snuke ridge, appear like separate hills rising behind each other, and then, with the Noup, may probably constitute the five hills of Foula with some, though, correctly speaking, it contains but two.

This island is chiefly composed of sandstone, resting on primary rocks; the upper 600 feet or 700 feet being of a loose texture, occasionally ferruginous, containing numerous small scales of mica dispersed through it. Pebbles of quartz, and fragments of other rocks, occur, but not frequently, and are arranged in layers and patches; the first conformable with the direction of the strata, which is also the line the patches assume in regard to each other. Green-earth also occurs in some places, in considerable quantities, in small compressed nodules, appearing, at first sight, like the fragments of a schistose rock dispersed in the sandstone. The sandstone, which occupies the upper part of the Snuke, has the direction of its strata nearly conformable with the line of the ridge, having its outgoings on the steep north slope of the hill, while it dips to the south-west, at an angle of about 12°, constituting the cliffs on the south-west side of the island, from Ravenbrag to the south point. Along that portion of the coast, from the softer nature of the rock, and the inclination of its base towards the sea, full scope is given to the action of the waves, and a scene of ruin and impending danger arrest the attention of the spectator; enormous masses, quite detached, seem ready to fall on the slightest application of force; while fragments, larger than the huts of Shetland, strew the shore. Among the cliffs of this shore may be seen some beautiful specimens of carious sandstone, produced by the action of the weather, the cells of great depth, and the septa of the most delicate thinness.

In descending from the Snuke ridge to the platform at the foot of Combe Hill, the sandstone then becomes more compact; and the small scales of mica, heretofore promiscuously arranged, are now disposed with thin, flat surfaces parallel to the stratification, and more or less in layers, giving the rock often a decided schistose character, when the mica is abundant,—an appearance which may also be discovered by weathering, even where the mica is scanty. As we continue to descend towards the north, the sandstone becomes still more compact, and often passes into, or alternates with, quartz rock, from which, however, the mica is rarely absent, though in some of the harder varieties it becomes again irregularly dispersed through it. At the north point of the island, opposite the Friar Rocks, we arrive at the lowest point in the regular stratification of the sandstone, proceeding from the Snuke ridge. In a small bay (marked *f* in the map), the sandstone is much undulated, and even contorted; the seams of stratification become wedge-shaped, curved, and leave the structure of the rock in an undefinable and unstratified mass. To the east and west of this point the strata again become remarkably straight, and their slaty structure well marked, differing in direction, however, on the opposite sides of the unstratified mass; that on the east side bearing 77° W. of N., while, on the west side, the direction of the strata is 105° W. of N. The Arched Friar, a singularly picturesque rock, arched in two opposite directions, and supported on four columns, I conjecture, belongs to the unstratified portion to which it is opposite, and to which, I imagine, it owes its ability to resist the action of the waves.

This occasional interruption of the stratification of a rock in the line of its direction, is a circumstance that deserves to be well studied. A most remarkable instance of the same kind occurs near Lambaness, in the Island of Stronsa.

Among the lower beds of the sandstone, a few thin layers of limestone occur, very compact, of a blue colour, and resembling siliceous schistus; argillaceous matter also, in combination with the mica in very thin lamina, serve occasionally to give the sandstone a schistose structure. But the circumstance most worthy of attention, is the occurrence of some thin beds of indurated clay, containing minute scales of mica; these are from a foot to two inches in thickness. The sandstone in the immediate vicinity has much the appearance of quartz-rock, and fills up numerous rents and openings of the indurated clay, which is chiefly separated by openings vertical to the plane of stratification, presenting appearances similar to what clay assumes in drying. The following sketch of a small portion will convey a notion of the manner in which it occurs, in which the white spaces represent the sandstone with its branches alternating with and traversing the clay, which forms the black parts of the figure.



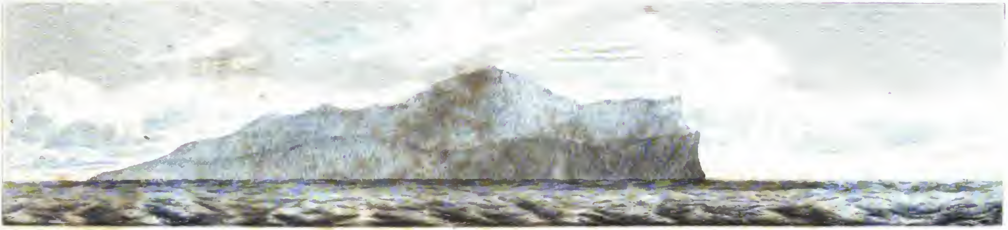
Proceeding from the north point of the island to the eastward, the strata have their direction 77° W. of N.; when two-thirds across the open bay, the sandstone begins to rise towards the promontory (B), its direction and dip bending round at right angles to their former bearing. Its rise towards B is at first very gentle; but near the point (*a*) the dip rapidly assumes an angle of 70°, where a small gully divides the sandstone from the primary rocks; and, on the east side of the gully, an apparent chaos of primitive rocks meets the eye; thick tortuous beds or veins of graphic granite intersect gneiss and mica-slate in the most fantastic manner; and veins or beds of quartz, of a calcedonic appearance, of a foot and more in thickness, tend to increase the variety. An attentive examination, however, shews, that the gneiss and mica-slate, and even the granite veins, have a general tendency to one direction and dip; and a view of the east side of the rock A, which accompanies this description, will shew the nature of the association. The dip is a little to the E. of S. The granite veins, however, are not always parallel with the dip of the strata; on the contrary, as is seen in the section of the rock A, they sometimes intersect them at right angles. I observed in one place a section, in the direction of the stratification, display two curved veins of granite, inclosing a portion of mica-slate.

At the promontory B, the mica-slate contains much hornblende, and in some places is studded with garnets. Felspar occurs also between the layers, by which means it passes into gneiss, to which it seems subordinate. On the east side of the promontory B, all appearance of gneiss and mica-slate is lost, and an unstratified mass of fine-grained graphic granite extends for half a mile along the coast to the point C. This granite is of the same nature with the veins already mentioned; the felspar, which is in excess,

PLATE X.

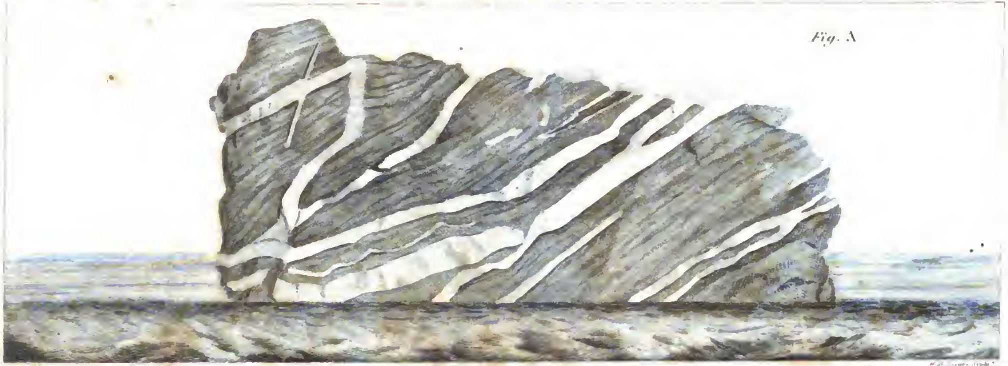
Wern. Memoirs Vol. IV. P. 242.

Fig. 1.



Island of Foula bearing S.W. by W¼W 6 or 7 Leagues

Fig. A



Granite Veins in Gneiss Island of Foula.

is sometimes nearly compact, and so abundant, as, without its geological connections, would render the name of granite rather inapplicable *. At the point C, the unstratified rock terminates, and a narrow cave or fissure at that place prevents an inspection of its contact with the succeeding rocks. On the south side of the fissure, at (C), gneiss rocks occur, dipping to 25° (S. of E.), at an angle of 45°, and extend for a space of a mile and a half to (*d*), varying or curving in the direction of the strata, the most general being the magnetic north, nearly at right angles to the general dip of the sandstone. Subordinate to the gneiss occur beds of mica-slate, hornblende-slate, and compact felspar, and occasionally veins of large-granular granite present themselves. The junction, near the point *d*, of the sandstone and gneiss is effected by gradations so minute, as to render it difficult to point out the precise spot, affording a remarkable contrast with the junction of these rocks at the north end of the island. At the point *e*, a bed of unstratified quartzose rock occurs, apparently bending up the strata of the superimposed sandstone. Among the primary rocks of Foula, minute crystals of iron and copper pyrites often occur disseminated.

The distinction of Primary and Secondary rocks in this island may be rather comparative than real; for, though the sandstone occasionally partakes both of the character of primary sandstone and quartz-rock, it also alternates with, and at last passes into, sandstone of a much newer aspect. The Transition class, in this instance, seems a very convenient division to refer it to.

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* The nature and connections of this granite are somewhat similar to those of Ronas Hill and Ben Layel.

The lines drawn on the map, distinguishing the boundaries of the different rocks, are in a great measure conjectural, as the surface has there a deep covering of peat-moss, and the only clue is that afforded by the direction of these lines as they occur at the coast; but as their extent is small, the direction and length assigned to them cannot differ much from the truth.

The Island of Foula, except on the very steep acclivities, is covered with peat-moss to a considerable depth; and the circumstance of laying waste the country, for the purposes of fuel and roofing, which so constantly distresses the eye in Orkney, is here almost rendered impossible. At Stanisfield, however, a portion of the Noup Hill, the covering of peat-moss being scanty, the natives have managed by perseverance to get down to the naked rock; and they seem disposed to prevent an accumulation of soil again in that place, as I observed some of them employed in cutting for fuel the scattered tufts, the remains of former attacks. This system of carrying off the soil, so prevalent in Orkney and Fair Isle, cannot be sufficiently deprecated, or too soon put an end to, as hundreds of acres of good land are every year consigned to sterility, though abundance of peat-moss is never far distant. Along the margins of the brooks in Foula, white and red clover, of natural growth, appear in considerable luxuriance; and should Mr Leisk, the worthy proprietor of Uya, be able to draw the attention of the Shetland proprietors to pasture, instead of cornfields, Foula may, after no great lapse of time, present over its greater extent rich crops of grass, instead of the heath and scanty herbage it at present affords.

The number of inhabitants in Foula amounts to about 165. And it is a curious fact, that during the last seven years there has been no marriage in the island, nor illegitimate children;—in this respect affording an extraordinary contrast to the state of Fair Isle. Nor does the contrast end there. In Fair Isle, the natives are in general half-starved and ill-clothed, seem squalid and unhealthy, and have a look of savage apathy. In Foula, the reverse is the case: in every respect the inhabitants seem to be much at their ease, are decently clothed, and are of a cheerful, inquisitive character. Indeed, I met no peasantry in Shetland that equal them. Their frank, free disposition, simple primitive manners, render them a very amiable people. It seems difficult to account for the difference between the inhabitants of two small islands so near, and in every respect so similarly situate. The difficulty entirely ceases, however, when it is known that the Fair Islanders live principally by smuggling, and the Foulaese by fishing: much may also be due to the exertions of the proprietor of the island, Mr Scott.

Our arrival in Foula, to carry on there the operations of the Trigonometrical Survey, excited the wonder of the Foulaese very much; they never ceased to express their admiration of the marquees and tents, and other objects of novelty. But when they understood our intention of carrying our baggage to the summit of the Snuke, and living among the bonxies, they considered the attempt would be fruitless and rash. An elderly man, looking at the great theodolite in its case, exclaimed, "It's a bonny box; but it's no in the poor o' man to take that up the Snuke." When, however, they saw our lusty artillerymen set off with heavy packages up the steep ascent of Snifield, a kind of emulation seized them, and we were enabled to hire about twenty of them, on easy terms, to assist; and the same evening we had an encampment of eight tents on the Snuke. A respectable old woman, who seemed to pay great respect to the Hill Trows, gave us her blessing at parting, assured, that if we were really going to live among the bonxies, we should never return safe again. The men, too, feared "the bonny claith-houses would never stand the north winters." The news from the metropolis arrives in Foula a few months after date, a good deal changed in its course northward, but more adapted to the ideas of the Foulaese. I was seriously asked if it was true the King was coming to Foula.

The name of Foula being supposed by some to have been imposed from the quanity of fowl that inhabit it, in a description of the island, some notice of these may be given; and, though ill qualified for the task, I shall state some particulars relating to such of the feathered tribes as particularly distinguish Foula, and shall therefore commence with the Bonxie, or Skua Gull, the *Lestris cataractes* of naturalists.

This bird, I believe, in the British Islands, breeds only in Shetland, and there only on three hills, the Snuke, Ronas, and Saxafiord, which are also the three highest. On Foula they seem to have taken exclusive possession of the Snuke. In its nature it appears to partake both of the nature of the gull and eagle tribes. On Foula, it breeds generally about a height of 1300 feet, and nowhere but on the Snuke. It is easily tamed, and is, I understand, a very docile bird [*]. I often observed it walking about within a few yards of the tent, and without fearing our approach. When, however, his nest is approached, he shews a determination to defend his possession with his life. Ravens, eagles, hawks, or other birds, are soon pursued from the territory they inhabit. On approaching the nest, an attack instantly commences; male and female in rapid succession descend from a considerable height, with a velocity and noise truly startling; horses, cattle, and sheep, are immediately put to flight, and receive no intermission of attack till well driven from the nest; and if man, bent on sinister purposes, continues to brave the bonxie's fury, he will seldom accomplish his aim without carrying away marks of war. The nest is a mere concavity in the ground; the number of eggs two; the month of breeding July. The young bird is a nimble, gallant little animal, and almost as soon as hatched leaves the nest. On the approach of danger he secrets himself in holes, or behind stones, with great art; and when captured, at last makes a shew of defence that is quite amusing. The number of these birds that annually breed at Foula probably does not exceed thirty pair.

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[*] A young one, which I kept for some time, and afterwards sent to Mr Neill, Canonmills, near Edinburgh, has proved remarkably docile. It is now (May 1822) acquiring new plumage, which has every resemblance to that of the mature bird.

The Arctic Gull (*Lestris parasiticus*) deserves the next place in the description of the birds of Foula. This elegant bird, which I have observed in Orkney to breed in single pairs, or at most in two or three pairs in one place, seems to have selected Foula for its head-quarters, and here it is chiefly congregated on the elevated platform under Combe Hill. Solitary pairs may be found in other places; but at the place above mentioned, the number of pairs breeding in 1821 probably did not fall short of 100; and having established that as the seat of power, they are no less tenacious of this domain than the bonxie, from which they exclude all other birds. And the Skua, when it happens to stray into the adjoining territory, is pursued by such a host of nimble enemies, as often leave him no resource but to alight, when the tactic of the Arctic gull is lost; his long wings, so advantageous to him on the wing, being quite the reverse on the ground. They are equally fierce with the bonxie in the defence of their nest, and make up in superior velocity their deficiency of weight. The rushing noise that accompanies the darting resembles that of a small rocket. The Arctic gull employs the same stratagems with the plover to decoy enemies from its nest. Placing itself at some distance from its retreat, it assumes the appearance of being disabled and incapable of flying, even making repeated tumbles, and continues to excite pursuit in a direction opposite to that of its nest, till a safe distance is obtained; the Arctic gull then mounts with extraordinary velocity: and I may venture to say, that, to a person ignorant of the trick, the stratagem is conducted with an art that never fails of success.

In approaching the nest of the Arctic gull, an attack still more fierce than that of the Skua commences. The intruder receives constant flaps with the wings of the bird. Judging from the rapidity of the dart, and their just grazing the head of the person, I imagined, if any hard substance was suddenly elevated above the head a few inches at the moment previous to the graze, the animal would probably terminate its existence against it. I accordingly elevated the muzzle of a fowling-piece a few inches above my head, and after a few trials, in which the bird shewed a most extraordinary power of altering its course when almost touching the gun, the experiment ended by its death; and so great was the force with which it struck the gun, that its brains were forced out, and the death was instantaneous; and I have no doubt an adroit person might kill numbers in this way. The form of the nest, number, colour, and shape of the eggs, resemble that of the Skua, as also the time of breeding. The young birds, or scories, are of a very handsome dark-speckled brown; the old birds are generally of a blackish colour all over, with exception of the belly, which is of a rusty or tarnished appearance. Considerable numbers, however, appear with white bellies, and a few variously speckled on the breast, forming a gradation between those with black and those with white bellies. These varieties of colour, I imagine, are the effect of different ages, having observed pairs belonging to the same nest associated in every possible mode of combining the colours, as two whites, two blacks, a white and black, a white and speckled, and a black speckled, and two speckled. I should imagine that not less than 150 pairs breed in Foula.

The Kittiwake Gull (*Larus rissa*), from their numbers, are next in importance, and are remarkable in their adopting a very peculiar and circumscribed place of breeding; they are all congregated in a natural arch, with which the north-west point of the cliff of Foula is perforated. It seems a habit of this bird to prefer covered places of breeding, and the number that crowd into the arch is so great as to completely whiten the face of the rock, and where the fowler, if he is disposed, may destroy them by bushels.

The Puffin (*Alca arctica*) breeds in great numbers on all the high cliffs of Foula, and their number probably exceeds that of all the other birds put together.

That well known bird of the sailors, Mother Cary's Chicken (*Procellaria pelagica*), conceived by many of them to breed under the sea, and never to alight on land, breeds in Foula in considerable numbers; and an abundant supply, both of old live birds and young ones, or eggs, may be obtained from the boys of Foula for a very trifling reward. The eggs are of a dull-white colour, and very round at both ends.

Ravens are in considerable numbers in Foula, and I observed them more numerous on one high cliff of great height, which I have named Raven Crag in the map, though probably it has a native name attached to it, few features of the island being without them; but probably the omission of native names to minute parts will not be regretted, as many of them can only be pronounced by a native, of which the Snuke is an instance, as it is somewhat difficult to say whether the concluding consonant should be *k*, *g*, or *d*, though I think the *k* comes considerably the nearest.

I saw some Eagles, but am informed they do not breed on Foula at present.

The Sea-pie, or Oyster-catcher, occurs in considerable numbers in Foula along the low shores; as also the small Guillemot, and the Danish Duck. Of Plovers and Curlews, so plentiful in other isles of Shetland, I did not observe an individual; and I was told the appearance of curlews on the coast of Foula was a sure indication of an approaching storm.

Seals are abundant on the coast of Foula in the month of July, both of the large and small species; the place of resort seems chiefly to be under the high cliffs between the Combe and the Kittiwake Walk. I imagine I saw not less than forty in one day.

The curiosities of Foula, chiefly detailed by the natives, are, I am afraid, no longer to be found. The carbuncle, seen by boatmen under the high cliffs of Combe Hill, is not confined to Foula, as the same phenomenon is said to occur off Hoy.

I regret I did not examine the Lum of Snifield, a crevice near the summit of the peak of that name, which the natives allege descends perpendicularly to the level of the sea (1130 feet), and then to have a subterranean passage to the ocean. Of the truth of which, they adduce the circumstance of a dog pursuing a sheep, which precipitated itself into the crevice, and was followed by the dog, and both were found afterwards at the mouth of a small cave by the coast. It would, however, appear at present, if the natives did not impose on some of our party, that the lum has ceased to exist, as they could discover nothing but loose stones filling the heretofore unfathomable abyss.

The following is a register of the weather in the month of July, on the summit of Foula, or about 1340 feet above the level of the sea.

Register of the Weather on the Snuke Hill of Foula, *July* 1821.

Sign — signifies before noon, and sign + after noon.

Days.	Hours.	Barom.	Ther.	Ther.	General Remarks.
8	+11			41	High north-wind, and fog.
9	+12			38	Light do., very foggy, with showers.
10	+10½			39	Fresh do., fog clearing away.
11	+ 2¾	28,8	48¾	48½	
	+11			43	
12	— 8	28,737	47½	46	Calm.
13	+ 2	28,523	48½	46	Calm.
15	—10½	28,488	49	49	Calm. Foggy. Wind S.
	+11			42	
16	— 8	28,297	48	46	Wind W. A gale, with fog.
17	— 6	29,275	44	45	
18	— 9½	28,755	49½	48	Wind S. A gale, and thick fog.
	+11	28,848	50	49	
19	— 7¾	28,824	52	50½	Wind S. Moderate. Flying mists.
	+10	28,667	49½	49½	Wind S. with fog. Blowing.
20	— 9	28,505	51	50½	Wind S. Fog on hill.
	+10½	28,210	50	48	Wind S. Fresh, with showers.
21	— 4	28,133	50½		Wind S. with fogs.
	— 8	28,118	52	50½	Do. do.
	+12	28,170	53½	48	Do. do.
22	— 8	28,242	56	52	Clear, calm weather.
23	— 8	27,982	52	52	Wind SE. Thick fog down to shore.
24	— 8	28,046	50	50	Wind ESE. Fog.
	+ 3½		55	55	Wind SE. Fog.
	+11	28,058	48	48	Do. do.
25	— 8	28,037	50½	50	Do. do.
	+12	28,092	48½	47	Clear on hill, haze in the distance.
26	— 8	28,122	53½	54	Calm. Clear on hill.
	+11	28,206	48	48	Do. do.
27	— 8	28,278	52	52	Calm, clear. W. wind about 9.
	+11	28,277	45½	45	Wind W. by N. Showers.
28	— 8	28,282	49	48	Do. do.
	+ 8½	28,238	48½	47½	Wind W. do.
	+11	28,228	44½	43	Calm.
29	— 8	28,306	50	48	Wind NE. (light). Clear.
	+11	28,362	47	46	Calm.
30	— 4	28,320	44½	43	Wind SE. (light). Clear.
	— 8	28,320	52	50	Do. do.